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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**	ATTORNEY'S DOCKET NUMBER 1454.1202 10/018796	
INTERNATIONAL APPLICATION NO. PCT/DE00/01759	INTERNATIONAL FILING DATE 30 May 2000	PRIORITY DATE CLAIMED 24 June 1999

TITLE OF INVENTION
ELECTRONIC CIRCUIT ARRANGEMENT GENERATING A TRANSMIT FREQUENCY

APPLICANT(S) FOR DO/EO/US
Volker DETERING et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☒ This is an express request to immediately begin national examination procedures (35 U.S.C. 371(f)).
3. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
4. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
5. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
6. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
7. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
8. ☒ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)).
9. ☐ A translation of the Annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 10-15 below concern document(s) or information included:

10. ☒ An Information Disclosure Statement Under 37 CFR 1.97 and 1.98.
11. ☐ An assignment document for recording.
    Please mail the recorded assignment document to:
    a. ☐ the person whose signature, name & address appears at the bottom of this document.
    b. ☐ the following:
12. ☒ A preliminary amendment.
13. ☒ A substitute specification
14. ☐ A change of power of attorney and/or address letter.
15. ☐ Other items or information:

PCT EASY forms filed with International Application, copy of cover page of International Application as published, International Search Report, and International Preliminary Examination Report.

10/018796

JC03 Rec'd PCT/PTO 21 DEC 2001

☒ The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees as follows:

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
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	BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4): ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO .....$1,040 ☒ International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO.....$ 890 ☐ International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO...$ 740 ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provision of PCT Article 33(1)-(4).....$ 710 ☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2) to (4) .....$ 100				890.00
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PATENT TRADEMARK OFFICE

SUBMITTED BY: STAAS & HALSEY LLP

Type Name	Richard A. Gollhofer	Reg. No.	31,106
Signature	Richard A. Gollhofer	Date	12/21/01

Docket No.: 1454.1202

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Volker DETERING et al.

Serial No. Group Art Unit:

Confirmation No.

Filed: (concurrently) Examiner:

For: ELECTRONIC CIRCUIT GENERATING A TRANSMIT FREQUENCY (as amended)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Before examination of the above-identified application, please amend the application as follows:

IN THE TITLE:

Please DELETE "ARRANGEMENT".

IN THE SPECIFICATION:

Please REPLACE the pending specification with the substitute specification attached hereto.

IN THE CLAIMS:

Please cancel without prejudice or disclaimer claims 1-15 in the underlying PCT application. Please also cancel claims 1-15 without prejudice or disclaimer and ADD new claims 16-30 in accordance with the following:

16. (NEW) An electronic circuit for generating a transmit frequency for a transceiver comprising:

a controllable oscillator to generate an output at an oscillator frequency;

a divider, coupled to said controllable oscillator, to produce an output with a frequency 1/N of the oscillator frequency; and

a mixer stage having inputs coupled to the outputs of said controllable oscillator and said divider and producing an output. used in generating a signal at the transmit frequency.

17. (NEW) The electronic circuit as claimed in claim 16, further comprising a band filter, coupled to the output of said mixer stage, to generate the signal at the transmit frequency.

18. (NEW) The electronic circuit as claimed in claim 17, further comprising a phase locked loop circuit coupled to an input of said controllable oscillator to provide a reference frequency and to receive as an input at least one of the output of said controllable oscillator and the signal at the transmit frequency produced by the band filter.

19. (NEW) The electronic circuit as claimed in claim 17, further comprising

a transmit output stage coupled to receive the signal at the transmit frequency from said band filter; and

a control device, coupled to the output of said mixer stage when said transmit output stage is switched on, to superimpose on an oscillator control signal a data signal to generate a frequency modulation of the output of said controllable oscillator.

20. (NEW) The electronic circuit as claimed in claim 16, wherein said mixer stage comprises a single-sideband mixer.

21. (NEW) The electronic circuit as claimed in claim 20, wherein said single-sideband mixer is an Image Reject Mixer.

22. (NEW) The electronic circuit as claimed in claim 20, further comprising a phase locked loop circuit coupled to an input of said controllable oscillator to provide a reference frequency and to receive as an input at least one of the output of said controllable oscillator and the output of said single-sideband mixer.

23. (NEW) The electronic circuit as claimed in claim 22, further comprising

a transmit output stage coupled to receive the signal at the transmit frequency from said single-sideband mixer; and

a control device, coupled to the output of said single-sideband mixer when said transmit output stage is switched on, to superimpose on an oscillator control signal a data signal to generate a frequency modulation of the output of said controllable oscillator.

24. (NEW) The electronic circuit as claimed in claim 23, wherein said control device is an ASIC component.

25. (NEW) The electronic circuit as claimed in claim 23, wherein said control device activates two switches alternately, to disconnect the control input of the oscillator upon switching on said transmit stage by said phase locked loop circuit and to supply the data signal for frequency modulation.

26. (NEW) The electronic circuit as claimed in claim 25, further comprising

a superimposition receiver, coupled to the output of said controllable oscillator to obtain a superimposition frequency directly from the oscillator frequency; and

a switch circuit having a first input used during transmission coupled to the output of said mixer stage, a second input used during reception coupled to said controllable oscillator, and an output coupled to said phase locked loop circuit.

27. (NEW) The electronic circuit as claimed in claim 16, further comprising an amplifier having an input coupled to the output of said mixer stage.

28. (NEW) The electronic circuit as claimed in claim 16, wherein said controllable oscillator is voltage-controlled.

29. (NEW) The electronic circuit as claimed in claim 16, wherein said controllable oscillator is current-controlled.

30. (NEW) The electronic circuit as claimed in claim 16, wherein a reference frequency is supplied externally.

31. (NEW) The electronic circuit as claimed in claim 16, further comprising a modulator, coupled between said divider and said mixer stage, to supply an IQ modulation baseband signal.

32. (NEW) The electronic circuit as claimed in claim 31, wherein said modulator performs vector modulation.

33. (NEW) The electronic circuit as claimed in the preceding claim 32, wherein the output from said divider, phase-shifted by 0°/90°, is used in generation of the vector modulation of said modulator.

34. (NEW) The electronic circuit as claimed in claim 16, further comprising a modulation stage at an output of said electronic circuit to perform modulation of the transmit signal.

35. (NEW) The electronic circuit as claimed in claim 31, wherein said modulation stage is a vector modulation stage.

IN THE ABSTRACT:

Please DELETE the Abstract in its entirety and replace with the attached Substitute Abstract.

REMARKS

This Preliminary Amendment is submitted to improve the form of the English translation as filed. It is respectfully requested that this Preliminary Amendment be entered in the above-referenced application.

In accordance with the foregoing, claims 1-15 have been canceled and claims 16-35 have been added. Thus, claims 16-35 are pending and are under consideration.

A substitute specification is also being filed herewith. The substitute specification is accompanied by a marked-up copy of the original specification.

If there are any questions regarding these matters, such questions can be addressed by telephone to the undersigned. Otherwise, an early action on the merits is respectfully solicited.

If any further fees are required in connection with the filing of this Preliminary Amendment, please charge same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

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SUBSTITUTE SPECIFICATION

TITLE OF THE INVENTION

ELECTRONIC CIRCUIT FOR GENERATING A TRANSMIT FREQUENCY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Patent Application No. 19928998 filed on June 24, 1999, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to an electronic circuit for generating a transmit frequency for a transceiver.

2. Description of the Related Art

[0003] The inventors are familiar with similar circuits from the prior art for generating corresponding transmit frequencies in a TDMA radio system (for example DECT, GSM, PHS). The abbreviation TDMA stands for "Time Division Multiple Access". A typical circuit is composed of an oscillator for generating frequencies, a transmit amplifier, a receiver and a control device which determines the chronological sequence of alternating transmit and receive states. In general, the oscillator frequency for setting the transmission channel via the control device using a PLL (phase locked loop) is set before the switching on of the transmitter since, for technical reasons, a certain setting time is required for this process. The invention relates to the case of transmission in such a TDMA system as illustrated schematically in Fig. 1.

[0004] The problem of such a simple circuit is that the generation of frequencies is disrupted at the moment of the switching on of the transmit amplifier owing to the load change in the amplifier or due to feedback. As a result, an undesired frequency jump is generated. Such a load change occurs, for example, during the switching on of the transmit amplifier as a result of the change in its input impedance. An effect on the generation of frequencies can arise, for example, owing to irradiation by the antenna, or due to other coupling parts between the transmit output stage and the generation of frequencies, for example due to the supply voltage.

[0005] In particular in TDMA systems which, for costs reasons, operate with a slow PLL control loop, or open the control loop for the duration of the modulation, this effect is a large problem for the implementation because the frequency jump can no longer be corrected by the PLL circuit. An example of this is the open-loop modulation of a DECT system.

[0006] The abovementioned problem is tackled by various circuits known to the inventors. For example, there is a possibility of bringing about a reduction in the load change which is visible for the generation of frequencies by inserting damping elements and isolating stages between the frequency generating components and the transmit amplifier. In addition, additional shielding of the frequency generating components in the form of a Faraday cage can ensure that the irradiation is reduced. Furthermore, additional blocking against electromagnetic irradiation, for example by specially shaped plugs, can be provided on the lines which lead into the shield. An example of such a known circuit device is shown in Fig. 2.

[0007] It is also known that the insertion of frequency multiplication stages or divider stages in the frequency generating components prevents the feedback and thus the influence on the frequency generating components. Here, an oscillator oscillates at a harmonic or subharmonic of the desired frequency, as a result of which both a low load dependence and a lower sensitivity to the irradiation of undesired frequencies is produced in accordance with the degree of multiplication or division. This circuit is illustrated schematically in Fig. 3.

[0008] Finally, the relatively costly use of a transmission mixing concept, such as is illustrated schematically in Fig. 4, for solving the abovementioned problem is known to the inventors.

[0009] In this transmission mixing concept, the frequencies of two oscillators are mixed in a mixer stage and the desired frequency filtered out from the mixing products. Because the oscillators have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to the load changes and effects. As a result, the requirements made of the shielding, the blocking and the isolation stages are reduced considerably in comparison with the known solutions from Figs. 2 and 3.

[0010] The greatest disadvantage of this transmission mixing concept is the large degree of technical expenditure which it requires because a transmission mixer stage, an oscillator including a PLL circuit for frequency stabilization and a band filter are additionally required. The additionally required electronic components alone result in a considerable cost disadvantage in comparison with the two preceding solutions.

[0011] A further disadvantage of this more costly transmission mixing concept is that the overall size of such a circuit is too large owing to the number of additional electronic components.

[0012] In this transmission mixing concept, it proves particularly difficult to achieve a high degree of integration because given the current state of the art the filters and oscillators or oscillator coils are very difficult to accommodate in integrated circuits, or require a very large

chip area. In addition, it is frequently impossible to integrate to a sufficient degree the capacitors and resistors which are required for the PLL so that they have to be arranged as external components.

[0013] Because a total of two oscillators for frequency stabilization, two PLLs, including two external loop filters, are necessary in the known transmission mixing concept, and in particular oscillators with a low frequency require a particularly large chip area or have poor properties with respect to phase noise, this transmission mixing concept proves relatively unsuitable for a high integration density.

SUMMARY OF THE INVENTION

[0014] The object of the invention is therefore to disclose an electronic circuit for generating a transmission frequency which on the one hand offers the favorable technical requirements of the transmission mixing concept and on the other hand permits a high integration density of the circuit to be achieved, and thus makes cost-effective manufacture possible.

[0015] Accordingly, an electronic circuit is proposed for generating a transmit frequency f_s for a transceiver, which circuit contains the following components: a controllable oscillator for generating an oscillator frequency f_{osz}, a divider by a factor N and a mixer stage with a subsequent band filter, the components being connected to one another in such a way that the oscillator frequency f_{osz} and an oscillator frequency f_{osz}/N divided by the factor N are fed to the mixer as input signals and output by it as transmit frequency f_s.

[0016] A significant advantage of this circuit is that a lower phase noise is produced with the circuit according to the invention than would be achievable with the two oscillators of the known transmission mixing concept because only a single oscillator can contribute to the phase noise.

[0017] A simplification of the structure of the circuit is achieved by virtue of the fact that, instead of the mixer stage with subsequent band filter, a single-sideband mixer or Image Reject Mixer is used. Single-sideband mixers are available as ready-made components and can be integrated into the circuit structure in a compact fashion.

[0018] A further advantageous refinement of the electronic circuit according to the invention can consist in using a PLL circuit for stabilization, to which PLL circuit a reference frequency, and either the oscillator frequency or the output frequency of the band filter or if appropriate of the single-sideband mixer, are fed as input signals.

[0019] Furthermore, it may be advantageous if the factor N of the divider supplies a multiple of the number 2 and/or is greater than 1 and supplies two output signals which are phase-shifted with respect to one another by 90°.

[0020] The desired phase shift by 90° can be achieved by phase shifting part of the signal by 90° and maintaining the original phase for the remaining part of the signal, or by phase shifting both parts of the signal by +45° and –45°, respectively. In both cases, a phase difference of 90° remains.

[0021] A further advantageous refinement of the electronic circuit according to the invention can consist in the fact that a control device is additionally provided which, at the time of the switching on of a transmit output stage connected to the output of the single-sideband mixer, superimposes on an oscillator control signal a data signal for generating a frequency modulation. Such a control device is used, for example, in what is referred to as TDMA systems.

[0022] In respect of optimal integration and simple implementation of the circuit it is also advantageous to implement the control device using an ASIC component.

[0023] Another advantageous refinement of the circuit provides for the control device to activate two switches alternately, which enables a connection of the oscillator control input either to a data modulator or, for the purpose of channel setting, to the PLL.

[0024] Furthermore, an alternative refinement to the electronic circuit according to the invention can consist in the fact that a superimposition receiver is provided which obtains a superimposition frequency directly from the oscillator frequency f_{osz}, and that a changeover device is provided which in the case of transmission feeds the single-sideband mixer output frequency and in the case of reception feeds the oscillator frequency to the PLL.

[0025] The oscillator can advantageously operate in a voltage-controlled or current-controlled fashion, for example, and if appropriate a reference frequency can also be fed externally.

[0026] Of course, the abovementioned features of the invention which are to be explained can be used not only in the respective specified combination but also in other combinations or alone without departing from the scope of the invention.

[0027] Further features and advantages of the invention emerge from the following description of preferred exemplary embodiments with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The invention will be explained below in more detail with reference to the drawings, in which, in particular:

Figures 1-4 are circuit diagrams from the prior art;

Figure 5 is a circuit diagram for a circuit with a mixer and subsequent band filter;

Figure 6 is a circuit diagram for a circuit with single-sideband mixer;

Figures 7-10 are circuit diagrams with different modulator arrangements;

Figure 11 is a circuit diagram for a circuit with superhet receiver and use of the oscillator at the receiver end;

Figure 12 is a circuit diagram for a circuit with single-sideband mixer and superhet receiver with a transmit/receive band filter;

Figure 13 is a circuit diagram for a circuit with single-sideband mixer and TDMA control device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0030] Figure 1 shows a known circuit for a TDMA radio system with an oscillator 2 and a PLL circuit 1 for generating a frequency which is as stable as possible, a TDMA controller 3 of a transmitting amplifier 4 and an antenna 5.

[0031] In this circuit, at the moment of the switching on of the transmitting amplifier 4, the generation of frequencies is disrupted owing to a load change and/or effects – indicated by the arrows 6 and 7 – and an undesired frequency jump is produced. The load change occurs during the switching on of the transmitting amplifier 4 as a result of the change in its input impedance.

[0032] Effects on the frequency generating components are produced as a result of the irradiation by the antenna 5, or by other coupling paths (not illustrated here) between the transmit output stage and the frequency generating components. An example of this are the supply voltage feeder lines.

[0033] Figure 2 shows a known circuit for avoiding the frequency jump. The circuit contains, in addition to the components illustrated in Fig. 1, the damping elements 8, 9 and one or more further amplifier stages for reducing the load change which is visible to the frequency generating components. Additional shielding (Faraday Cage) 12 of the frequency generating components

for reducing irradiation is also illustrated. Furthermore, there is usually high frequency blocking (not illustrated here) of the lines leading into the shielding.

[0034] Figure 3 shows a further known variant of a frequency generating circuit with a frequency multiplication stage or divider stage 13. In this example, the oscillator 2 oscillates at a harmonic or subharmonic of the desired transmit frequency, as a result of which both a lower load dependence and a lower sensitivity to electromagnetic irradiation arises in accordance with the degree of multiplication or division.

[0035] The best known circuit with the most effective suppression of feedback and frequency jumps during the switching on of the transmitting amplifier is illustrated in Fig. 4. This Fig. 4 shows a circuit for generating a transmit frequency using a transmission mixing concept. Here, the frequency of the first oscillator 2 and to the first PLL circuit 1, and the second frequency of the second oscillator 2 and to the second PLL circuit 15 is mixed in the mixer stage 16, and the desired frequency is filtered out of the mixing products by the band filter 17.

[0036] If the frequencies of the oscillators 2 and 14 are selected such that they have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to load changes, that is to say during the switching on of the transmitting amplifier, and to its effects. As a result, the requirements made of the shielding, blocking and isolating stages are reduced considerably in comparison with the circuits illustrated in Figs. 2 and 3. The expenditure on circuitry is disadvantageous because a mixer stage 16, an oscillator 14 and a PLL circuit 15 for frequency stabilization and a band filter 17 are additionally required.

[0037] Figure 5 shows a simple circuit according to the invention for a radio system in which a high degree of cost savings can be achieved by a good degree of integration. The transmission mixing concept was selected as a starting point, but the second oscillator was dispensed with.

[0038] The second arrangement is composed, at the input end, of a single oscillator 2 which is stabilized by a PLL circuit 1. A summing stage 18, by which an FM modulation signal 26 can be supplied, is arranged between the oscillator 2 and the PLL circuit 1. The frequency f_{osz} of the oscillator 2 is fed to a frequency divider 19, and the frequency f_{osz}/N is generated. Both frequencies f_{osz} and f_{osz}/N are then fed to a mixer 32 in order to form the transmit frequency f_s. In the subsequent band filter 22, the undesired secondary frequencies which have also been produced are filtered out and the filtered frequency is conducted to the amplifier output stage 4. Either the oscillator frequency f_{osz} can be fed back to the PLL circuit 1 via the line 34, or the transmit frequency f_s can be fed back to the PLL circuit 1 from the output of the band filter 33.

[0039] The desired transmit frequency f_s is thus obtained by:

$$f_s = f_{osz} \pm \left(\frac{f_{osz}}{N}\right) = f_{osz} * \left(1 \pm \frac{1}{N}\right)$$

where fs = transmit frequency, f_{osz} = oscillator frequency, N = divider factor

[0040] As is apparent from the mathematical relationship, a nonintegral relationship results between the transmit frequency f_s and the oscillator frequency f_{osz}, which promises a good degree of immunity to effects. The selection of the signs in the formula is determined by the connection of the single-sideband mixer. There is the freedom to allow the oscillator to oscillate either below or above the desired frequency. Basically, the oscillator frequency f_{osz} can also be selected in such a way that the oscillator frequency f_{osz} fulfils the criterion of the best phase noise (best quality of the coil) given the equipment.

[0041] In addition to the circuit according to the invention for generating the transmit frequency, a TDMA controller 31, known per se, for which the circuit for generating frequencies according to the invention is particularly suitable is also illustrated in Fig. 5.

[0042] Figure 6 shows a further development of the circuit according to the invention from Fig. 5.

[0043] In this further development, a single-sideband mixer or Image Reject Mixer 20 was used instead of the mixer 32 and the subsequent band filter 33. If the operating conditions require it, another filter element (not illustrated) for suppressing the harmonics of the divided signal can also be used downstream of the divider 19.

[0044] The single-sideband mixer 20 typically has a first phase shifter 21 for phase shifting and dividing the incoming oscillator frequency f_{osz} and a second phase shifter 22 for phase shifting the incoming divided oscillator frequency f_{osz}/N by 90° in each case. These frequencies which are each phase-shifted by 90° are mixed in the mixers 23 and 24, superimposed in the summing stage 25 and output as a desired transmit frequency f_s.

[0045] It is to be noted that the purpose of the phase shifting of 0° and 90° illustrated here can also be achieved by a phase shift by –45° and +45°.

[0046] The desired transmit frequency f_s is also obtained here and in all the further examples in accordance with the same formula to be described with respect to Fig. 5.

[0047] Since the frequency divider and single-sideband mixer can be integrated without difficulty with the contemporary technologies, this circuit leads to a considerable saving in chip area. Furthermore, there is a saving of a PLL with the external components of the loop filter connected thereto.

[0048] Another circuit according to the invention for generating a transmit frequency is illustrated in Fig. 7. The oscillator frequency f_{osz} is fed on the one hand to a divider 19 and on the other hand to a phase shifter 36. By using a factor N which can be divided by two, the phase shift of 90° required for the principle of single-sideband mixing can advantageously be generated easily and precisely, as a result of which there is better suppression of the undesired sideband from the mixing process.

[0049] The output signals which are shifted by 90° are obtained in a generally known way in that the last divider stage of a divider chain is a double design, one of the two divider stages being fed the input signal in inverted form.

[0050] Figure 8 shows a variant of the simple embodiment of the circuit according to the invention from Fig. 5 with a mixer 33 and downstream band filter 33. The difference with respect to Fig. 5 is that here a modulation signal 41 is emitted to a modulator 40 which is arranged between the divider 19 and mixer 32. This modulator 40 can be embodied, for example, as a vector modulator. The mixer 32 which is illustrated in simplified form contains in practice two individual mixers, each being responsible for one signal.

[0051] Such an embodiment has the advantage that any desired, even multivalued types of modulation can be generated with good frequency and/or phase stability.

[0052] The modulation signal 4 which is supplied can, for example, be the IQ baseband, generated by a digital signal processor, of a GMSK, N-PSK or quadrature amplitude modulation.

[0053] Another modification of the circuit according to the invention is illustrated in Fig. 9. This corresponds essentially to Fig. 5, but here, in order to generate and modulate the transmit frequency, two frequencies $f_{osz}(0°)$ and $f_{osz}(90°)$ which are phase-shifted by 90° and divided by N are fed to a mixer stage 39, which simultaneously operates as a modulator in that it mixes the data signals into baseband conditioning signals I and Q. The output signals are then conducted to the summing stage 25 and fed to the mixer 32. Here, the advantage arises from the precisely generated 0°/90° phase shift from the divider N which is required by the IQ modulator.

[0054] In the mixer 32, the transmit frequency f_s including secondary frequencies is in turn generated by mixing with the oscillator frequency f_{osz}, the secondary frequencies are largely

filtered out during passage through the subsequent band filter 33 and the remaining transmit frequency f_s is conducted to the transmitting amplifier 4 and irradiated via the antenna 5. As in Fig. 5, the optional TDMA controller 31 is also illustrated.

[0055] A further possible way of transferring a modulation onto the transmit signal is illustrated in Fig. 10. The circuit also corresponds here to the simple design from Fig. 5, but a modulation is not superimposed on the oscillator frequency, but rather, instead of the band filter 33, a modulator 40, to which a modulation signal 41 is fed by a baseband, is arranged downstream of the mixer 32. This is therefore a "combination" of the design with an IQ modulator with which any desired types of modulation can be implemented, as illustrated in Figs. 8 and 9.

[0056] Figures 5 to 10 thus show a very wide variety of possibilities of modulating a transmit frequency f_s generated according to the invention by different types of modulation such as GMSK (Gaussian minimum shift keying), nPSK (n-multiple phase shift keying) or QAM (quadrature amplitude modulation).

[0057] Figure 11 shows a further circuit which illustrates a combination of frequency generation with a superhet receiver and provides further advantages. The basic design of the circuit corresponds to the circuit from Fig. 6, but there is additionally a superimposition receiver 36 with integrated receive mixer 37 and the additional changeover switch 38, which permits the same PLL step size in the transmitting and receiving modes.

[0058] In the receiving mode, the oscillator 2 generates the superimposition signal, while in the case of transmission the same oscillator 2 is used to generate the transmit frequency. The intermediate frequency in the case of reception is selected in such a way that it lies in the vicinity of the oscillator offset frequency in the case of transmission. The tuning range of the receiver is somewhat smaller in accordance with the offset between the transmit frequency and oscillator frequency, which however has hardly any effect in practice with relatively large divider factors. The coupling with the PLL is carried out by the changeover switch 38, downstream of the single-sideband mixer 20 in the case of transmission and directly by the oscillator 2 in the case of reception, in order to permit a uniform tuning step size of the PLL with the same reference frequency. It is advantageous here that only a single oscillator 2 is necessary for the transmitting mode and the receiving mode and at the same time good stability of the transmit frequency is achieved in the TDMA mode.

[0059] This circuit design shown is particularly suitable for DECT systems.

[0060] A disadvantage of the circuit according to the invention in comparison with an oscillator which operates at the limit frequency, namely the additional undesired mixing products of a real single-sideband mixer, can be reduced by adding a high-frequency filter, necessary in any case in the receiver, upstream of the transmit/receive changeover switch. In this case, the filter is used both for the transmit branch and for the receive branch.

[0061] Such a solution is illustrated by way of example in Fig. 12, which, apart from the transmitting amplifier 4, corresponds to the circuit from Fig. 6. The transmit/receive changeover switch 28, which changes over between the transmit amplifier 4 and the receiver 30 (indicated by broken lines) is arranged subsequently. The aforementioned high-frequency filter 29 is connected between the antenna 5 and the transmit/receive changeover switch 28.

[0062] Finally, Fig. 13 also shows a circuit according to the invention with a single-sideband mixer 20 as described with respect to Fig. 6. In this case, the TDMA controller 31 however ensures that a data signal for generating a frequency modulation is superimposed on the oscillator control signal at the time of the switching on of the transmit output stage.

[0063] This is an arrangement such as is used, for example, in a DECT system with "open-loop modulation method". When the switch 32 is closed, the oscillator 2 is set to the desired channel by the PLL circuit 1 during a time slot which is not required for the transmitting/receiving mode. Just before the start of transmission, the switch 32 opens and the control variable which is acquired up to that point is stored in a storage element, not illustrated separately in Fig. 13. A baseband signal for generating the DECT-GFSK (Gaussian frequency shift keying) modulation is superimposed by the switch 32 during the emission of the stored control variable. The necessary frequency stability is made possible during the emission by the arrangement according to the invention of the divider and mixer or single-sideband mixer. That is to say, high-frequency effects from the transmitter stage on the oscillator 2 do not bring about any frequency offset after the switching on of the transmitter.

[0064] In total, the circuit according to the invention therefore ensures that, on the one hand, the favorable technical requirements of the transmission mixing concept can be utilized and, on the other hand, a high integration density of the circuit, and thus cost-effective manufacture are made possible.

[0065] The invention has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

ABSTRACT

ELECTRONIC CIRCUIT FOR GENERATING A TRANSMIT FREQUENCY

A transmit frequency is generated for a transceiver by a controllable oscillator which generates an oscillator frequency, a divider by a factor N, and a mixer stage with a subsequent band filter. Signals with the oscillator frequency and the oscillator frequency divided by the factor N are fed to the mixer stage to generate an output signal at the transmit frequency.

MARKED-UP COPY OF SUBSTITUTE SPECIFICATION

[Description] TITLE OF THE INVENTION

ELECTRONIC CIRCUIT [ARRANGEMENT] FOR GENERATING A TRANSMIT FREQUENCY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Patent Application No. 19928998 filed on June 24, 1999, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to an electronic circuit [arrangement] for generating a transmit frequency for a transceiver.

2. Description of the Related Art

[0003] The inventors are familiar with similar [circuit arrangements] circuits from the prior art for generating corresponding transmit frequencies in a TDMA radio system (for example DECT, GSM, PHS). The abbreviation TDMA stands for "Time Division Multiple Access". [Such an arrangement] A typical circuit is composed of an oscillator for generating frequencies, a transmit amplifier, a receiver and a control device which determines the chronological sequence of alternating transmit and receive states. In general, the oscillator frequency for setting the transmission channel via the control device using a PLL (phase locked loop) is set before the switching on of the transmitter since, for technical reasons, a certain setting time is required for this process. The invention relates to the case of transmission in such a TDMA system [whose arrangement is] as illustrated schematically in [figure] Fig. 1.

[0004] The problem of such a simple circuit [arrangement] is that the generation of frequencies is disrupted at the moment of the switching on of the transmit amplifier owing to the load change in the amplifier or due to feedback. As a result, an undesired frequency jump is generated. Such a load change occurs, for example, during the switching on of the transmit amplifier as a result of the change in its input impedance. An effect on the generation of frequencies can arise, for example, owing to irradiation by the antenna, or due to other coupling parts between the transmit output stage and the generation of frequencies, for example due to the supply voltage.

[0005] In particular in TDMA systems which, for costs reasons, operate with a slow PLL control loop, or open the control loop for the duration of the modulation, this effect is a large problem for

the implementation because the frequency jump can no longer be corrected by the PLL circuit. An example of this is the open-loop modulation of a DECT system.

[0006] The abovementioned problem is tackled by [means of] various [circuit arrangement] circuits known to the inventors. For example, there is a possibility of bringing about a reduction in the load change which is visible for the generation of frequencies by inserting damping elements and isolating stages between the frequency generating [means] components and the transmit amplifier. In addition, additional shielding of the frequency generating [means] components in the form of a Faraday cage can ensure that the irradiation is reduced. Furthermore, additional blocking against electromagnetic irradiation, for example by [means of] specially shaped plugs, can be provided on the lines which lead into the shield. An example of such a known circuit device is shown in [figure] Fig. 2.

[0007] It is also known that the insertion of frequency multiplication stages or divider stages in the frequency generating [means] components prevents the feedback and thus the influence on the frequency generating [means] components. Here, an oscillator oscillates at a harmonic or subharmonic of the desired frequency, as a result of which both a low load dependence and a lower sensitivity to the irradiation of undesired frequencies is produced in accordance with the degree of multiplication or division. This circuit is illustrated schematically in [figure] Fig. 3.

[0008] Finally, the relatively costly use of a transmission mixing concept, such as is illustrated schematically in [figure] Fig. 4, for solving the abovementioned problem is known to the inventors.

[0009] In this transmission mixing concept, the frequencies of two oscillators are mixed in a mixer stage and the desired frequency filtered out from the mixing products. Because the oscillators have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to the load changes and effects. As a result, the requirements made of the shielding, the blocking and the isolation stages are reduced considerably in comparison with the known solutions from [figures] Figs. 2 and 3.

[0010] The greatest disadvantage of this transmission mixing concept is the large degree of technical expenditure which it requires because a transmission mixer stage, an oscillator including a PLL circuit for frequency stabilization and a band filter are additionally required. The additionally required electronic components alone result in a considerable cost disadvantage in comparison with the two preceding solutions.

[0011] A further disadvantage of this more costly transmission mixing concept is that the overall size of such a circuit [arrangement] is too large owing to the number of additional electronic components.

[0012] In this transmission mixing concept, it proves particularly [problematic] difficult to achieve a high degree of integration because given the current state of the art the filters and oscillators or oscillator coils are very difficult to accommodate in integrated circuits, or require a very large chip area. In addition, it is frequently impossible to integrate to a sufficient degree the capacitors and resistors which are required for the PLL so that they have to be arranged as external components.

[0013] Because a total of two oscillators for frequency stabilization, two PLLs, including two external loop filters, are necessary in the known transmission mixing concept, and in particular oscillators with a low frequency require a particularly large chip area or have poor properties with respect to phase noise, this transmission mixing concept proves relatively unsuitable for a high integration density.

SUMMARY OF THE INVENTION

[0014] The object of the invention is therefore to disclose an electronic circuit [arrangement] for generating a transmission frequency which [electronic circuit arrangement] on the one hand offers the favorable technical requirements of the transmission mixing concept and on the other hand permits a high integration density of the circuit to be achieved, and thus makes cost-effective manufacture possible. [The object is achieved by means of the features of claim 1.]

[0015] Accordingly, an electronic circuit [arrangement] is proposed for generating a transmit frequency f_s for a transceiver, which circuit contains the following components: a controllable oscillator for generating an oscillator frequency f_{osz}, a divider by a factor N and a mixer stage with a subsequent band filter, the components being connected to one another in such a way that the oscillator frequency f_{osz} and an oscillator frequency f_{osz}/N divided by the factor N are fed to the mixer as input signals and output by it as transmit frequency f_s.

[0016] A significant advantage of this [arrangement] circuit is that a lower phase noise is produced with the circuit [arrangement] according to the invention than would be achievable with the two oscillators of the known transmission mixing concept because only a single oscillator can contribute to the phase noise.

[0017] A simplification of the structure of the circuit is achieved by virtue of the fact that, instead of the mixer stage with subsequent band filter, a single-sideband mixer [(=] or Image Reject

Mixer[)] is used. Single-sideband mixers are available as ready-made components and can be integrated into the circuit structure in a compact fashion.

[0018] A further advantageous refinement of the electronic circuit [arrangement] according to the invention can consist in using a PLL circuit for stabilization, to which PLL circuit a reference frequency, and either the oscillator frequency or the output frequency of the band filter or if appropriate of the single-sideband mixer, are fed as input signals.

[0019] Furthermore, it may be advantageous if the factor N of the divider supplies a multiple of the number [of the] 2 and/or is greater than 1 and supplies two output signals which are phase-shifted with respect to one another by 90°.

[0020] The desired phase shift by 90° can be achieved by [the] phase shifting [of] part of the signal by 90° and [maintenance of] maintaining the original phase for the remaining part of the signal, or by phase shifting both parts of the signal by +45° and –45°, respectively. In both cases, a phase difference of 90° remains.

[0021] A further advantageous refinement of the electronic circuit [arrangement] according to the invention can consist in the fact that a control device is additionally provided which, at the time of the switching on of a transmit output stage connected to the output of the single-sideband mixer, superimposes on an oscillator control signal a data signal for generating a frequency modulation. Such a control device is used, for example, in what is referred to as TDMA systems.

[0022] In respect of optimal integration and simple implementation of the circuit it is also advantageous to implement the control device using an ASIC component.

[0023] Another advantageous refinement of the circuit [arrangement] provides for the control device to activate two switches alternately, which enables a connection of the oscillator control input either to a data modulator or, for the [purposes] purpose of channel setting, to the PLL.

[0024] Furthermore, an alternative refinement to the electronic circuit [arrangement] according to the invention can consist in the fact that a superimposition receiver is provided which obtains a superimposition frequency directly from the oscillator frequency f_{osz}, and that a changeover device is provided which in the case of transmission feeds the single-sideband mixer output frequency and in the case of reception feeds the oscillator frequency to the PLL.

[0025] The oscillator can advantageously operate in a voltage-controlled or current-controlled fashion, for example, and if appropriate a reference frequency can also be fed externally.

[0026] Of course, the abovementioned features of the invention which are to be explained can be used not only in the respective specified combination but also in other combinations or alone without departing from the scope of the invention.

[0027] Further features and advantages of the invention emerge from the following description of preferred exemplary embodiments with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The invention will be explained below in more detail with reference to the drawings, in which, in particular:

[Figs.] Figures 1-4[: show circuit arrangements] are circuit diagrams from the prior art;

[Fig.] Figure 5[: shows] is a circuit diagram for a circuit [arrangement] with a mixer and subsequent band filter;

[Fig.] Figure 6[: shows] is a circuit diagram for a circuit [arrangement] with single-sideband mixer;

[Figs.] Figures 7-10[: show circuit arrangements] are circuit diagrams with different modulator arrangements;

Figure 11[: shows] is a circuit diagram for a circuit [arrangement] with superhet receiver and use of the oscillator at the receiver end;

Figure 12[: shows] is a circuit diagram for a circuit [arrangement] with single-sideband mixer and superhet receiver with a transmit/receive band filter;

Figure 13[: shows] is a circuit diagram for a circuit [arrangement] with single-sideband mixer and TDMA control device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0030] Figure 1 shows a known circuit [arrangement] for a TDMA radio system with an oscillator 2 and a PLL circuit 1 for generating a frequency which is as stable as possible, a TDMA controller 3 of a transmitting amplifier 4 and an antenna 5.

[0031] In this circuit [arrangement], at the moment of the switching on of the transmitting amplifier 4, the generation of frequencies is disrupted owing to a load change and/or effects – indicated by the arrows 6 and 7 – and an undesired frequency jump is produced. The load

change occurs during the switching on of the transmitting amplifier 4 as a result of the change in its input impedance.

[0032] Effects on the frequency generating [means] components are produced as a result of the irradiation by the antenna 5, or by other coupling paths (not illustrated here) between the transmit output stage and the frequency generating [means] components. An example of this are the supply voltage feeder lines.

[0033] Figure 2 shows a known circuit for avoiding the frequency jump. The circuit contains, in addition to the components illustrated in [figure] Fig. 1, the damping elements 8, 9 and one or more further amplifier stages for reducing the load change which is visible to the frequency generating [means] components. Additional shielding (Faraday Cage) 12 of the frequency generating [means] components for reducing irradiation is also illustrated. Furthermore, there is usually high frequency blocking [means] (not illustrated here) of the lines leading into the shielding.

[0034] Figure 3 shows a further known variant of a frequency generating circuit with a frequency multiplication stage or divider stage 13. In this example, the oscillator 2 oscillates at a harmonic or subharmonic of the desired transmit frequency, as a result of which both a lower load dependence and a lower sensitivity to electromagnetic irradiation arises in accordance with the degree of multiplication or division.

[0035] The best known circuit with the most effective suppression of feedback and frequency jumps during the switching on of the transmitting amplifier is illustrated in [figure] Fig. 4. This [figure] Fig. 4 shows a circuit [arrangement] for generating a transmit frequency using a transmission mixing concept. Here, the frequency of the first oscillator 2 and to the first PLL circuit 1, and the second frequency of the second oscillator 2 and to the second PLL circuit 15 is mixed in the mixer stage 16, and the desired frequency is filtered out of the mixing products by [means of] the band filter 17.

[0036] If the frequencies of the oscillators 2 and 14 are selected such that they have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to load changes, that is to say during the switching on of the transmitting amplifier, and to its effects. As a result, the requirements made of the shielding, blocking and isolating stages are reduced considerably in comparison with the [circuit arrangements from figures] circuits illustrated in Figs. 2 and 3. The expenditure on circuitry is disadvantageous because a mixer

stage 16, an oscillator 14 and a PLL circuit 15 for frequency stabilization and a band filter 17 are additionally required.

[0037] Figure 5 shows a simple circuit [arrangement] according to the invention for a radio system in which a high degree of cost savings can be achieved by a good degree of integration. The transmission mixing concept was selected as a starting point, but the second oscillator was dispensed with.

[0038] The second arrangement is composed, at the input end, of a single oscillator 2 which is stabilized by [means of] a PLL circuit 1. A summing stage 18, by [means of] which an FM modulation signal 26 can be supplied, is arranged between the oscillator 2 and the PLL circuit 1. The frequency f_{osz} of the oscillator 2 is fed to a frequency divider 19, and the frequency f_{osz}/N is generated. Both frequencies f_{osz} and f_{osz}/N are then fed to a mixer 32 in order to form the transmit frequency f_s. In the subsequent band filter 22, the undesired secondary frequencies which have also been produced are filtered out and the filtered frequency is conducted to the amplifier output stage 4. Either the oscillator frequency f_{osz} can be fed back to the PLL circuit 1 via the line 34, or the transmit frequency f_s can be fed back to the PLL circuit 1 from the output of the band filter 33.

[0039] The desired transmit frequency f_s is thus obtained by:

$$f_s = f_{osz} \pm \left(\frac{f_{osz}}{N}\right) = f_{osz} * \left(1 \pm \frac{1}{N}\right)$$

where fs = transmit frequency, f_{osz} = oscillator frequency, N = divider factor

[0040] As is apparent from the mathematical relationship, a nonintegral relationship results between the transmit frequency f_s and the oscillator frequency f_{osz}, which promises a good degree of immunity to effects. The selection of the signs in the formula is determined by the connection of the single-sideband mixer. There is the freedom to allow the oscillator to oscillate either below or above the desired frequency. Basically, the oscillator frequency f_{osz} can also be selected in such a way that the oscillator frequency f_{osz} fulfils the criterion of the best phase noise (best quality of the coil) given the equipment.

[0041] In addition to the circuit [arrangement] according to the invention for generating the transmit frequency, a TDMA controller 31, known per se, for which the circuit [arrangement] for generating frequencies according to the invention is particularly suitable is also illustrated in [figure] Fig. 5.

[0042] Figure 6 shows a further development of the circuit [arrangement] according to the invention from [figure] Fig. 5.

[0043] In this further development, a single-sideband mixer [(=] or Image Reject Mixer[)] 20 was used instead of the mixer 32 and the subsequent band filter 33. If the operating conditions require it, another filter element (not illustrated) for suppressing the harmonics of the divided signal can also be used downstream of the divider 19.

[0044] The single-sideband mixer 20 typically has a first phase shifter 21 for phase shifting and dividing the incoming oscillator frequency f_{osz} and a second phase shifter 22 for phase shifting the incoming divided oscillator frequency f_{osz}/N by 90° in each case. These frequencies which are each phase-shifted by 90° are mixed in the mixers 23 and 24, superimposed in the summing stage 25 and output as a desired transmit frequency f_s.

[0045] It is to be noted that the purpose of the phase shifting of 0° and 90° illustrated here can also be achieved by a phase shift by –45° and +45°.

[0046] The desired transmit frequency f_s is also obtained here and in all the further examples in accordance with the same formula to be described with respect to [figure] Fig. 5.

[0047] Since the frequency divider and single-sideband mixer can be integrated without difficulty with the contemporary technologies, this circuit [arrangement] leads to a considerable saving in chip area. Furthermore, there is a saving of a PLL with the external components of the loop filter connected thereto.

[0048] Another circuit [arrangement] according to the invention for generating a transmit frequency is illustrated in [figure] Fig. 7. The oscillator frequency f_{osz} is fed on the one hand to a divider 19 and on the other hand to a phase shifter 36. By using a factor N which can be divided by two, the phase shift of 90° required for the principle of single-sideband mixing can advantageously be generated easily and precisely, as a result of which there is better suppression of the undesired sideband from the mixing process.

[0049] The output signals which are shifted by 90° are obtained in a generally known way in that the last divider stage of a divider chain is a double design, one of the two divider stages being fed the input signal in inverted form.

[0050] Figure 8 shows a variant of the simple embodiment of the circuit [arrangement] according to the invention from [figure] Fig. 5 with a mixer 33 and downstream band filter 33. The difference with respect to [figure] Fig. 5 is that here a modulation signal 41 is emitted to a

modulator 40 which is arranged between the divider 19 and mixer 32. This modulator 40 can be embodied, for example, as a vector modulator. The mixer 32 which is illustrated in simplified form contains in practice two individual mixers, each being responsible for one signal.

[0051] Such an embodiment has the advantage that any desired, even multivalued types of modulation can be generated with good frequency and/or phase stability.

[0052] The modulation signal 4 which is supplied can, for example, be the IQ baseband, generated by a digital signal processor, of a GMSK, N-PSK or quadrature amplitude modulation.

[0053] Another modification of the circuit [arrangement] according to the invention is illustrated in [figure] Fig. 9. This corresponds essentially to [figure] Fig. 5, but here, in order to generate and modulate the transmit frequency, two frequencies $f_{osz}(0°)$ and $f_{osz}(90°)$ which are phase-shifted by 90° and divided by N are fed to a mixer stage 39, which simultaneously operates as a modulator in that it mixes the data signals into [a] baseband conditioning [means] signals I and Q. The output signals are then conducted to the summing stage 25 and fed to the mixer 32. Here, the advantage arises from the precisely generated 0°/90° phase shift from the divider N which is required by the IQ modulator.

[0054] In the mixer 32, the transmit frequency f_s including secondary frequencies is in turn generated by mixing with the oscillator frequency f_{osz}, the secondary frequencies are largely filtered out during passage through the subsequent band filter 33 and the remaining transmit frequency f_s is conducted to the transmitting amplifier 4 and irradiated via the antenna 5. As in [figure] Fig. 5, the optional TDMA controller 31 is also illustrated.

[0055] A further possible way of transferring a modulation onto the transmit signal is illustrated in [figure] Fig. 10. The circuit [arrangement] also corresponds here to the simple design from [figure] Fig. 5, but a modulation is not superimposed on the oscillator frequency, but rather, instead of the band filter 33, a modulator 40, to which a modulation signal 41 is fed by a baseband, is arranged downstream of the mixer 32. This is therefore a "combination" of the design with an IQ modulator with which any desired types of modulation can be implemented, as illustrated in [figures] Figs. 8 and 9.

[0056] Figures 5 to 10 thus show a very wide variety of possibilities of modulating a transmit frequency f_s generated according to the invention by [means of] different types of modulation such as GMSK ([=] Gaussian minimum shift keying), nPSK ([=] n-multiple phase shift keying) or QAM ([=] quadrature amplitude modulation).

[0057] Figure 11 shows a further circuit [arrangement] which illustrates a combination of frequency generation with a superhet receiver and provides further advantages. The basic design of the circuit corresponds to the circuit [arrangement] from [figure] Fig. 6, but there is additionally a superimposition receiver 36 with integrated receive mixer 37 and the additional changeover switch 38, which permits the same PLL step size in the transmitting and receiving modes.

[0058] In the receiving mode, the oscillator 2 generates the superimposition signal, while in the case of transmission the same oscillator 2 is used to generate the transmit frequency. The intermediate frequency in the case of reception is selected in such a way that it lies in the vicinity of the oscillator offset frequency in the case of transmission. The tuning range of the receiver is somewhat smaller in accordance with the offset between the transmit frequency and oscillator frequency, which however has hardly any effect in practice with relatively large divider factors. The coupling with the PLL is carried out by [means of] the changeover switch 38, downstream of the single-sideband mixer 20 in the case of transmission and directly by the oscillator 2 in the case of reception, in order to permit a uniform tuning step size of the PLL with the same reference frequency. It is advantageous here that only a single oscillator 2 is necessary for the transmitting mode and the receiving mode and at the same time good stability of the transmit frequency is achieved in the TDMA mode.

[0059] This circuit design shown is particularly suitable for DECT systems.

[0060] A disadvantage of the circuit [arrangement] according to the invention in comparison with an oscillator which operates at the limit frequency, namely the additional undesired mixing products of a real single-sideband mixer, can be reduced by adding a high-frequency filter, necessary in any case in the receiver, upstream of the transmit/receive changeover switch. In this case, the filter is used both for the transmit branch and for the receive branch.

[0061] Such a solution is illustrated by way of example in [figure] Fig. 12, which, apart from the transmitting amplifier 4, corresponds to the circuit [arrangement] from [figure] Fig. 6. The transmit/receive changeover switch 28, which changes over between the transmit amplifier 4 and the receiver 30 (indicated by broken lines) is arranged subsequently. The aforementioned high-frequency filter 29 is connected between the antenna 5 and the transmit/receive changeover switch 28.

[0062] Finally, [figure] Fig. 13 also shows a circuit [arrangement] according to the invention with a single-sideband mixer 20 as [is] described [in figure] with respect to Fig. 6. In this case, the

TDMA controller 31 however ensures that a data signal for generating a frequency modulation is superimposed on the oscillator control signal at the time of the switching on of the transmit output stage.

[0063] This is an arrangement such as is used, for example, in a DECT system with "open-loop modulation method". When the switch 32 is closed, the oscillator 2 is set to the desired channel by [means of] the PLL circuit 1 during a time slot which is not required for the transmitting/receiving mode. Just before the start of transmission, the switch 32 opens and the control variable which is acquired up to that point is stored in a storage element, not illustrated separately in [the figure] Fig. 13. A baseband signal for generating the DECT-GFSK (Gaussian frequency shift keying) modulation is superimposed by [means of] the switch 32 during the emission of the stored control variable. The necessary frequency stability is made possible during the emission by the arrangement according to the invention of the divider and mixer or single-sideband mixer. That is to say, high-frequency effects from the transmitter stage on the oscillator 2 do not bring about any frequency offset after the switching on of the transmitter.

[0064] In total, the circuit [arrangement] according to the invention therefore ensures that, on the one hand, the favorable technical requirements of the transmission mixing concept can be utilized and, on the other hand, a high integration density of the circuit, and thus cost-effective manufacture are made possible.

[0065] The invention has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

ABSTRACT

ELECTRONIC CIRCUIT FOR GENERATING A TRANSMIT FREQUENCY

A transmit frequency is generated for a transceiver by a controllable oscillator which generates an oscillator frequency, a divider by a factor N, and a mixer stage with a subsequent band filter. Signals with the oscillator frequency and the oscillator frequency divided by the factor N are fed to the mixer stage to generate an output signal at the transmit frequency.

Description

Electronic circuit arrangement for generating a transmit frequency

The invention relates to an electronic circuit arrangement for generating a transmit frequency for a transceiver.

The inventors are familiar with similar circuit arrangements from the prior art for generating corresponding transmit frequencies in a TDMA radio system (for example DECT, GSM, PHS). The abbreviation TDMA stands for "Time Division Multiple Access". Such an arrangement is composed of an oscillator for generating frequencies, a transmit amplifier, a receiver and a control device which determines the chronological sequence of alternating transmit and receive states. In general, the oscillator frequency for setting the transmission channel via the control device using a PLL (phase locked loop) is set before the switching on of the transmitter since, for technical reasons, a certain setting time is required for this process. The invention relates to the case of transmission in such a TDMA system whose arrangement is illustrated schematically in figure 1.

The problem of such a simple circuit arrangement is that the generation of frequencies is disrupted at the moment of the switching on of the transmit amplifier owing to the load change in the amplifier or due to feedback. As a result, an undesired frequency jump is generated. Such a load change occurs, for example, during the switching on of the transmit amplifier as a result of the change in its input impedance. An effect on the generation of frequencies can arise, for example, owing to irradiation by the antenna, or due to other coupling parts between the transmit output stage and the

generation of frequencies, for example due to the supply voltage.

In particular in TDMA systems which, for costs reasons, operate with a slow PLL control loop, or open the control loop for the duration of the modulation, this effect is a large problem for the implementation because the frequency jump can no longer be corrected by the PLL circuit. An example of this is the open-loop modulation of a DECT system.

The abovementioned problem is tackled by means of various circuit arrangement known to the inventors. For example, there is a possibility of bringing about a reduction in the load change which is visible for the generation of frequencies by inserting damping elements and isolating stages between the frequency generating means and the transmit amplifier. In addition, additional shielding of the frequency generating means in the form of a Faraday cage can ensure that the irradiation is reduced. Furthermore, additional blocking against electromagnetic irradiation, for example by means of specially shaped plugs, can be provided on the lines which lead into the shield. An example of such a known circuit device is shown in figure 2.

It is also known that the insertion of frequency multiplication stages or divider stages in the frequency generating means prevents the feedback and thus the influence on the frequency generating means. Here, an oscillator oscillates at a harmonic or subharmonic of the desired frequency, as a result of which both a low load dependence and a lower sensitivity to the irradiation of undesired frequencies is produced in accordance with the degree of multiplication or division. This

circuit is illustrated schematically in figure 3.

Finally, the relatively costly use of a transmission mixing concept, such as is illustrated schematically in figure 4, for solving the abovementioned problem is known to the inventors.

In this transmission mixing concept, the frequencies of two oscillators are mixed in a mixer stage and the desired frequency filtered out from the mixing products. Because the oscillators have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to the load changes and effects. As a result, the requirements made of the shielding, the blocking and the isolation stages are reduced considerably in comparison with the known solutions from figures 2 and 3.

The greatest disadvantage of this transmission mixing concept is the large degree of technical expenditure which it requires because a transmission mixer stage, an oscillator including a PLL circuit for frequency stabilization and a band filter are additionally required. The additionally required electronic components alone result in a considerable cost disadvantage in comparison with the two preceding solutions.

A further disadvantage of this more costly transmission mixing concept is that the overall size of such a circuit arrangement is too large owing to the number of additional electronic components.

In this transmission mixing concept, it proves particularly problematic to achieve a high degree of integration because given the current state of the art the filters and oscillators or oscillator coils are very difficult to accommodate in integrated circuits, or

require a very large chip area. In addition, it is frequently impossible to integrate to a sufficient degree the capacitors and resistors which are required for the PLL so that they have to be arranged as external components.

Because a total of two oscillators for frequency stabilization, two PLLs, including two external loop filters, are necessary in the known transmission mixing concept, and in particular oscillators with a low frequency require a particularly large chip area or have poor properties with respect to phase noise, this transmission mixing concept proves relatively unsuitable for a high integration density.

The object of the invention is therefore to disclose an electronic circuit arrangement for generating a transmission frequency which electronic circuit arrangement on the one hand offers the favorable technical requirements of the transmission mixing concept and on the other hand permits a high integration density of the circuit to be achieved, and thus makes cost-effective manufacture possible.

The object is achieved by means of the features of claim 1.

Accordingly, an electronic circuit arrangement is proposed for generating a transmit frequency f_s for a transceiver, which circuit contains the following components: a controllable oscillator for generating an oscillator frequency f_{osz}, a divider by a factor N and a mixer stage with a subsequent band filter, the components being connected to one another in such a way that the oscillator frequency f_{osz} and an oscillator frequency f_{osz}/N divided by the factor N are fed to the mixer as input signals and output by it as transmit frequency f_s.

A significant advantage of this arrangement is that a lower phase noise is produced with the circuit arrangement according to the invention than would be achievable with the two oscillators of the known transmission mixing concept because only a single oscillator can contribute to the phase noise.

A simplification of the structure of the circuit is achieved by virtue of the fact that, instead of the mixer stage with subsequent band filter, a single-sideband mixer (= Image Reject Mixer) is used. Single-sideband mixers are available as ready-made components and can be integrated into the circuit structure in a compact fashion.

A further advantageous refinement of the electronic circuit arrangement according to the invention can consist in using a PLL circuit for stabilization, to which PLL circuit a reference frequency, and either the oscillator frequency or the output frequency of the band filter or if appropriate of the single-sideband mixer, are fed as input signals.

Furthermore, it may be advantageous if the factor N of the divider supplies a multiple of the number of the 2 and/or is greater than 1 and supplies two output signals which are phase-shifted with respect to one another by 90°.

The desired phase shift by 90° can be achieved by the phase shifting of part of the signal by 90° and maintenance of the original phase for the remaining part of the signal, or by phase shifting both parts of the signal by +45° and -45°, respectively. In both cases, a phase difference of 90° remains.

A further advantageous refinement of the electronic circuit arrangement according to the invention can consist in the fact that a control device is additionally provided which, at the

time of the switching on of a transmit output stage connected to the output of the single-sideband mixer, superimposes on an oscillator control signal a data signal for generating a frequency modulation. Such a control device is used, for example, in what is referred to as TDMA systems.

In respect of optimal integration and simple implementation of the circuit it is also advantageous to implement the control device using an ASIC component.

Another advantageous refinement of the circuit arrangement provides for the control device to activate two switches alternately, which enables a connection of the oscillator control input either to a data modulator or for the purposes of channel setting to the PLL.

Furthermore, an alternative refinement to the electronic circuit arrangement according to the invention can consist in the fact that a superimposition receiver is provided which obtains a superimposition frequency directly from the oscillator frequency f_{osz}, and that a changeover device is provided which in the case of transmission feeds the single-sideband mixer output frequency and in the case of reception feeds the oscillator frequency to the PLL.

The oscillator can advantageously operate in a voltage-controlled or current-controlled fashion, for example, and if appropriate a reference frequency can also be fed externally.

Of course, the abovementioned features of the invention which are to be explained can be used not only in the respective specified combination but also in other combinations or alone without departing from the scope of the invention.

Further features and advantages of the invention emerge from the following description of preferred exemplary embodiments with reference to the drawings.

The invention will be explained below in more detail with reference to the drawings, in which, in particular:

Figs. 1-4: show circuit arrangements from the prior art;

Fig. 5: shows a circuit arrangement with mixer and subsequent band filter;

Fig. 6: shows a circuit arrangement with single-sideband mixer;

Figs. 7-10: show circuit arrangements with different modulator arrangements;

Figure 11: shows a circuit arrangement with superhet receiver and use of the oscillator at the receiver end;

Figure 12: shows a circuit arrangement with single-sideband mixer and superhet receiver with a transmit/receive band filter;

Figure 13: shows a circuit arrangement with single-sideband mixer and TDMA control device.

Figure 1 shows a known circuit arrangement for a TDMA radio system with an oscillator 2 and a PLL circuit 1 for generating a frequency which is as stable as possible, a TDMA controller 3 of a transmitting amplifier 4 and an antenna 5.

In this circuit arrangement, at the moment of the switching on of the transmitting amplifier 4, the generation of frequencies is disrupted owing to a load change and/or effects - indicated by the arrows 6 and 7 - and an undesired frequency jump is produced. The load change occurs during the switching on of the transmitting amplifier 4 as a result of the change in its input impedance.

Effects on the frequency generating means are produced as a result of the irradiation by the antenna 5, or by other coupling paths (not illustrated here) between the transmit output stage and the frequency generating means. An example of this are the supply voltage feeder lines.

Figure 2 shows a known circuit for avoiding the frequency jump. The circuit contains, in addition to the components illustrated in figure 1, the damping elements 8, 9 and one or more further amplifier stages for reducing the load change which is visible to the frequency generating means. Additional shielding (Faraday Cage) 12 of the frequency generating means for reducing irradiation is also illustrated. Furthermore, there is usually high frequency blocking means (not illustrated here) of the lines leading into the shielding.

Figure 3 shows a further known variant of a frequency generating circuit with a frequency multiplication stage or divider stage 13. In this example, the oscillator 2 oscillates at a harmonic or subharmonic of the desired transmit frequency, as a result of which both a lower load dependence and a lower sensitivity to electromagnetic irradiation arises in accordance with the degree of multiplication or division.

The best known circuit with the most effective suppression of feedback and frequency jumps during the switching on of the transmitting amplifier is illustrated in figure 4. This figure 4 shows a circuit arrangement for generating a transmit frequency using a transmission mixing concept. Here, the frequency of the first oscillator 2 and to the first PLL circuit 1, and the second frequency of the second oscillator 2 and to the second PLL circuit 15 is mixed in

the mixer stage 16, and the desired frequency is filtered out of the mixing products by means of the band filter 17.

If the frequencies of the oscillators 2 and 14 are selected such that they have a nonharmonic relationship with the desired frequency, there is a resulting high degree of immunity to load changes, that is to say during the switching on of the transmitting amplifier, and to its effects. As a result, the requirements made of the shielding, blocking and isolating stages are reduced considerably in comparison with the circuit arrangements from figures 2 and 3. The expenditure on circuitry is disadvantageous because a mixer stage 16, an oscillator 14 and a PLL circuit 15 for frequency stabilization and a band filter 17 are additionally required.

Figure 5 shows a simple circuit arrangement according to the invention for a radio system in which a high degree of cost savings can be achieved by a good degree of integration. The transmission mixing concept was selected as a starting point, but the second oscillator was dispensed with.

The second arrangement is composed, at the input end, of a single oscillator 2 which is stabilized by means of a PLL circuit 1. A summing stage 18, by means of which an FM modulation signal 26 can be supplied, is arranged between the oscillator 2 and the PLL circuit 1. The frequency f_{osz} of the oscillator 2 is fed to a frequency divider 19, and the frequency f_{osz}/N is generated. Both frequencies f_{osz} and f_{osz}/N are then fed to a mixer 32 in order to form the transmit frequency f_s. In the subsequent band filter 22, the undesired secondary frequencies which have also been produced are filtered out and the filtered frequency is conducted to the amplifier output stage 4. Either the oscillator frequency f_{osz} can be fed back to the PLL circuit 1 via the line 34, or

the transmit frequency f_s can be fed back to the PLL circuit 1 from the output of the band filter 33.

The desired transmit frequency f_s is thus obtained by:

$$f_s = f_{osz} \pm \left(\frac{f_{osz}}{N}\right) = f_{osz} * \left(1 \pm \frac{1}{N}\right)$$

where fs = transmit frequency, f_{osz} = oscillator frequency, N = divider factor

As is apparent from the mathematical relationship, a nonintegral relationship results between the transmit frequency f_s and the oscillator frequency f_{osz}, which promises a good degree of immunity to effects. The selection of the signs in the formula is determined by the connection of the single-sideband mixer. There is the freedom to allow the oscillator to oscillate either below or above the desired frequency. Basically, the oscillator frequency f_{osz} can also be selected in such a way that the oscillator frequency f_{osz} fulfils the criterion of the best phase noise (best quality of the coil) given the equipment.

In addition to the circuit arrangement according to the invention for generating the transmit frequency, a TDMA controller 31, known per se, for which the circuit arrangement for generating frequencies according to the invention is particularly suitable is also illustrated in figure 5.

Figure 6 shows a further development of the circuit arrangement according to the invention from figure 5.

In this further development, a single-sideband mixer (= Image Reject Mixer) 20 was used instead of the mixer 32 and the subsequent band filter 33. If the operating conditions require it, another filter element (not illustrated) for suppressing the harmonics of the divided signal can also be used downstream of the divider 19.

The single-sideband mixer 20 typically has a first phase shifter 21 for phase shifting and dividing the incoming oscillator frequency f_{osz} and a second phase shifter 22 for phase shifting the incoming divided oscillator frequency f_{osz}/N by 90° in each case. These frequencies which are each phase-shifted by 90° are mixed in the mixers 23 and 24, superimposed in the summing stage 25 and output as a desired transmit frequency f_s.

It is to be noted that the purpose of the phase shifting of 0° and 90° illustrated here can also be achieved by a phase shift by -45° and +45°.

The desired transmit frequency f_s is also obtained here and in all the further examples in accordance with the same formula to be described with respect to figure 5.

Since the frequency divider and single-sideband mixer can be integrated without difficulty with the contemporary technologies, this circuit arrangement leads to a considerable saving in chip area. Furthermore, there is a saving of a PLL with the external components of the loop filter connected thereto.

Another circuit arrangement according to the invention for generating a transmit frequency is illustrated in figure 7. The oscillator frequency f_{osz} is fed on the one hand to a divider 19 and on the other hand to a phase shifter 36. By using a factor N which can be divided by two, the phase shift of 90° required for the principle of single-sideband mixing can advantageously be generated easily and precisely, as a result of which there is better suppression of the undesired sideband from the mixing process.

The output signals which are shifted by 90° are obtained in a generally known way in that the last divider stage of a divider chain is a double design, one of the two divider stages being fed the input signal in inverted form.

Figure 8 shows a variant of the simple embodiment of the circuit arrangement according to the invention from figure 5 with a mixer 33 and downstream band filter 33. The difference with respect to figure 5 is that here a modulation signal 41 is emitted to a modulator 40 which is arranged between the divider 19 and mixer 32. This modulator 40 can be embodied, for example, as a vector modulator. The mixer 32 which is illustrated in simplified form contains in practice two individual mixers, each being responsible for one signal.

Such an embodiment has the advantage that any desired, even multivalued types of modulation can be generated with good frequency and/or phase stability.

The modulation signal 4 which is supplied can, for example, be the IQ baseband, generated by a digital signal processor, of a GMSK, N-PSK or quadrature amplitude modulation.

Another modification of the circuit arrangement according to the invention is illustrated in figure 9. This corresponds essentially to figure 5, but here, in order to generate and modulate the transmit frequency, two frequencies $f_{osz}(0°)$ and $f_{osz}(90°)$ which are phase-shifted by 90° and divided by N are fed to a mixer stage 39, which simultaneously operates as a modulator in that it mixes the data signals into a baseband conditioning means I and Q. The output signals are then conducted to the summing stage 25 and fed to the mixer 32. Here, the advantage arises from the precisely generated 0°/90° phase shift from the divider N which is required by the IQ modulator.

In the mixer 32, the transmit frequency f_s including secondary frequencies is in turn generated by mixing with the oscillator frequency f_{osz}, the secondary frequencies are largely filtered out during passage through the subsequent band filter 33 and the remaining transmit frequency f_s is conducted to the transmitting amplifier 4 and irradiated via the antenna 5. As in figure 5, the optional TDMA controller 31 is also illustrated.

A further possible way of transferring a modulation onto the transmit signal is illustrated in figure 10. The circuit arrangement also corresponds here to the simple design from figure 5, but a modulation is not superimposed on the oscillator frequency, but rather, instead of the band filter 33, a modulator 40, to which a modulation signal 41 is fed by a baseband, is arranged downstream of the mixer 32. This is therefore a "combination" of the design with an IQ modulator with which any desired types of modulation can be implemented, as illustrated in figures 8 and 9.

Figures 5 to 10 thus show a very wide variety of possibilities of modulating a transmit frequency f_s generated according to the invention by means of different types of modulation such as GMSK (= Gaussian minimum shift keying), nPSK (= n-multiple phase shift keying) or QAM (= quadrature amplitude modulation).

Figure 11 shows a further circuit arrangement which illustrates a combination of frequency generation with a superhet receiver and provides further advantages. The basic design of the circuit corresponds to the circuit arrangement from figure 6, but there is additionally a superimposition receiver 36 with integrated receive mixer 37 and the

additional changeover switch 38, which permits the same PLL step size in the transmitting and receiving modes.

In the receiving mode, the oscillator 2 generates the superimposition signal, while in the case of transmission the same oscillator 2 is used to generate the transmit frequency. The intermediate frequency in the case of reception is selected in such a way that it lies in the vicinity of the oscillator offset frequency in the case of transmission. The tuning range of the receiver is somewhat smaller in accordance with the offset between the transmit frequency and oscillator frequency, which however has hardly any effect in practice with relatively large divider factors. The coupling with the PLL is carried out by means of the changeover switch 38, downstream of the single-sideband mixer 20 in the case of transmission and directly by the oscillator 2 in the case of reception, in order to permit a uniform tuning step size of the PLL with the same reference frequency. It is advantageous here that only a single oscillator 2 is necessary for the transmitting mode and the receiving mode and at the same time good stability of the transmit frequency is achieved in the TDMA mode.

This circuit design shown is particularly suitable for DECT systems.

A disadvantage of the circuit arrangement according to the invention in comparison with an oscillator which operates at the limit frequency, namely the additional undesired mixing products of a real single-sideband mixer, can be reduced by adding a high-frequency filter, necessary in any case in the receiver, upstream of the transmit/receive changeover switch. In this case, the filter is used both for the transmit branch and for the receive branch.

Such a solution is illustrated by way of example in figure 12, which, apart from the transmitting amplifier 4, corresponds to the circuit arrangement from figure 6. The transmit/receive

changeover switch 28, which changes over between the transmit amplifier 4 and the receiver 30 (indicated by broken lines) is arranged subsequently. The aforementioned high-frequency filter 29 is connected between the antenna 5 and the transmit/receive changeover switch 28.

Finally, figure 13 also shows a circuit arrangement according to the invention with a single-sideband mixer 20 as is described in figure 6. In this case, the TDMA controller 31 however ensures that a data signal for generating a frequency modulation is superimposed on the oscillator control signal at the time of the switching on of the transmit output stage.

This is an arrangement such as is used, for example, in a DECT system with "open-loop modulation method". When the switch 32 is closed, the oscillator 2 is set to the desired channel by means of the PLL circuit 1 during a time slot which is not required for the transmitting/receiving mode. Just before the start of transmission, the switch 32 opens and the control variable which is acquired up to that point is stored in a storage element, not illustrated separately in the figure. A baseband signal for generating the DECT-GFSK (Gaussian frequency shift keying) modulation is superimposed by means of the switch 32 during the emission of the stored control variable. The necessary frequency stability is made possible during the emission by the arrangement according to the invention of the divider and mixer or single-sideband mixer. That is to say, high-frequency effects from the transmitter stage on the oscillator 2 do not bring about any frequency offset after the switching on of the transmitter.

In total, the circuit arrangement according to the invention therefore ensures that, on the one hand, the favorable technical requirements of the transmission mixing concept can be utilized

and, on the other hand, a high integration density of the circuit, and thus cost-effective manufacture are made possible.

Patent Claims

1. An electronic circuit arrangement for generating a transmit frequency for a transceiver having the following features: a controllable oscillator (2) for generating an oscillator frequency (f_{osz}), a divider (19) by a factor N and a mixer stage (32) with a subsequent band filter (33) are connected to one another in such a way that the oscillator frequency (f_{osz}) and an oscillator frequency (f_{osz}/N) which is divided by the factor N are fed to the mixer stage (32) as input signals.

2. The electronic circuit arrangement as claimed in the preceding claim 1, characterized in that, instead of the mixer stage (32) with subsequent band filter (33), a single-sideband mixer (20) which is embodied in particular as an "Image Reject Mixer" is provided.

3. Electronic circuit arrangement as claimed in any of the preceding claims 1 to 2, characterized in that a PLL circuit (1) is provided for stabilizing the oscillator frequency (f_{osz}), to which PLL circuit (1) a reference frequency and either the oscillator frequency (f_{osz}) or the output frequency of the single-sideband mixer (20) or of the band filter (33) are fed as input signals.

4. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 3, characterized in that the factor N of the divider (19) is an integral multiple of the number 2 and supplies two output signals which are phase-shifted by 90°.

5. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 4, characterized

in that a control device (31) is provided which, at the time of the switching on of a transmit output stage (4) which is connected to the output of the mixer stage (32) with the subsequent band filter (33) or of the single-sideband mixer (20), superimposes on an oscillator control signal a data signal in order to generate a frequency modulation.

6. The electronic circuit arrangement as claimed in the preceding claim 5, characterized in that the control device (31) is an ASIC component.

7. The electronic circuit arrangement as claimed in one of the preceding claims 5 to 6, characterized in that the control device (31) activates two switches (32, 33) alternately, which disconnects the control input of the oscillator (2) at the time of the switching on of the transmit stage by the PLL circuit (1) and feeds in a data signal for purposes of frequency modulation.

8. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 7, characterized in that a superimposition receiver (36) is provided which obtains its superimposition frequency directly from the oscillator frequency (f_{osz}), and in that a changeover device (38) is provided which in the case of transmission is fed the output frequency to the mixer stage (32) with the subsequent band filter (33) or of the single-sideband mixer (20), and in the case of reception is fed the oscillator frequency to the PLL circuit (1).

9. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 8, characterized in that an amplifier (4) is provided at the output

of the mixer stage (32) with the subsequent band filter (33) or of the single-sideband mixer (20).

10. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 9, characterized in that the oscillator (2) is voltage-controlled.

11. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 9, characterized in that the oscillator (2) is current-controlled.

12. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 11, characterized in that a reference frequency (26) is supplied externally.

13. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 12, characterized in that a modulator (40, 39), preferably a vector modulator (39), with which a modulator signal is made available at the output of the mixer stage (32) by supplying an IQ modulation baseband signal, is arranged between the divider (19) and the mixer stage (32) or of the single-sideband mixer (20).

14. The electronic circuit arrangement as claimed in the preceding claim 13, characterized in that the signal which is acquired from the divider (19) and is phase-shifted by 0°/90° is included in the generation of the vector modulation of the modulator (39).

15. The electronic circuit arrangement as claimed in one of the preceding claims 1 to 2, characterized in that a modulation stage, preferably a vector modulation stage, which brings about modulation of the transmit signal, is arranged at the output of said electronic circuit.

Fig. 1

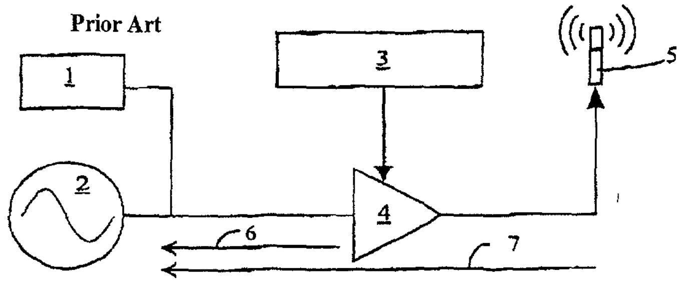


Fig. 2

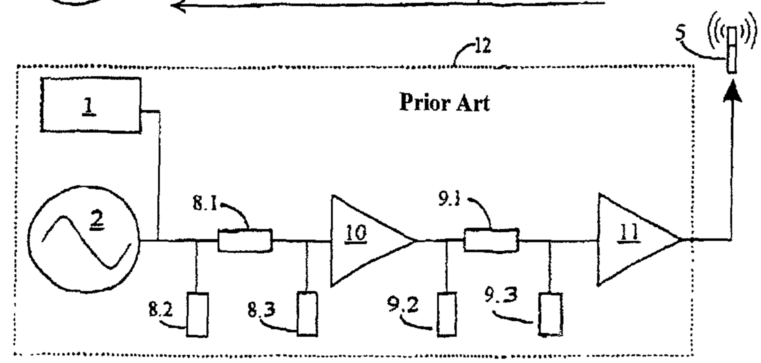


Fig. 3

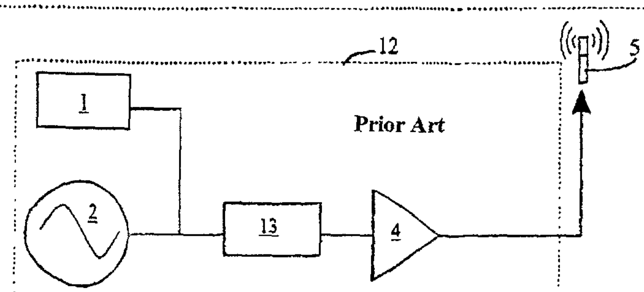
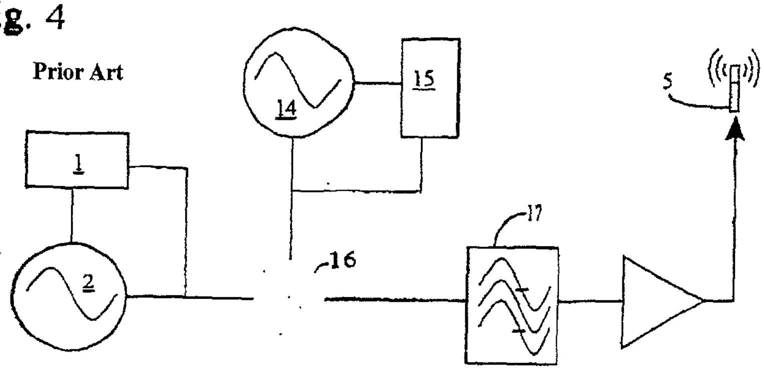


Fig. 4



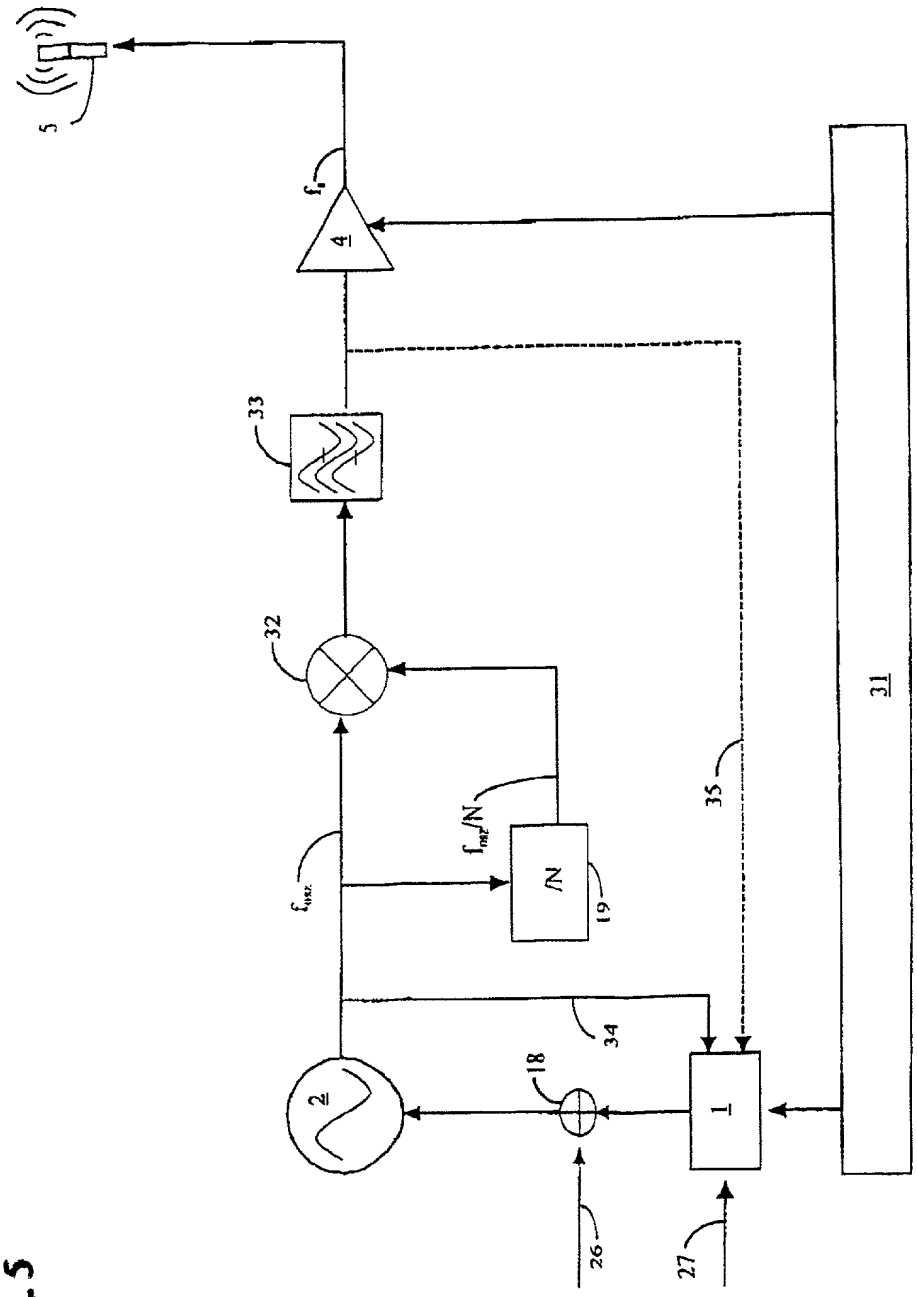


Fig. 5

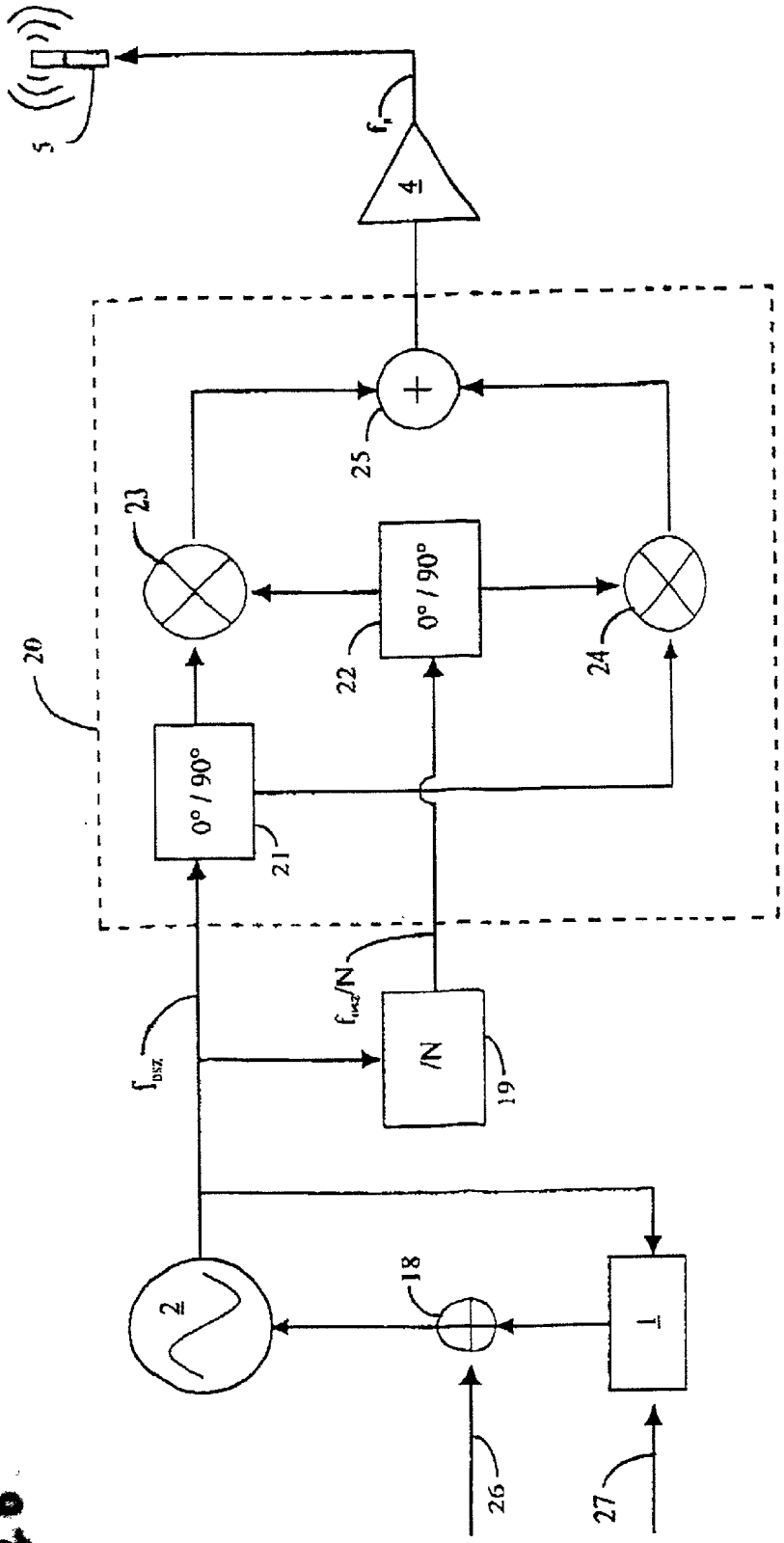


Fig. 6

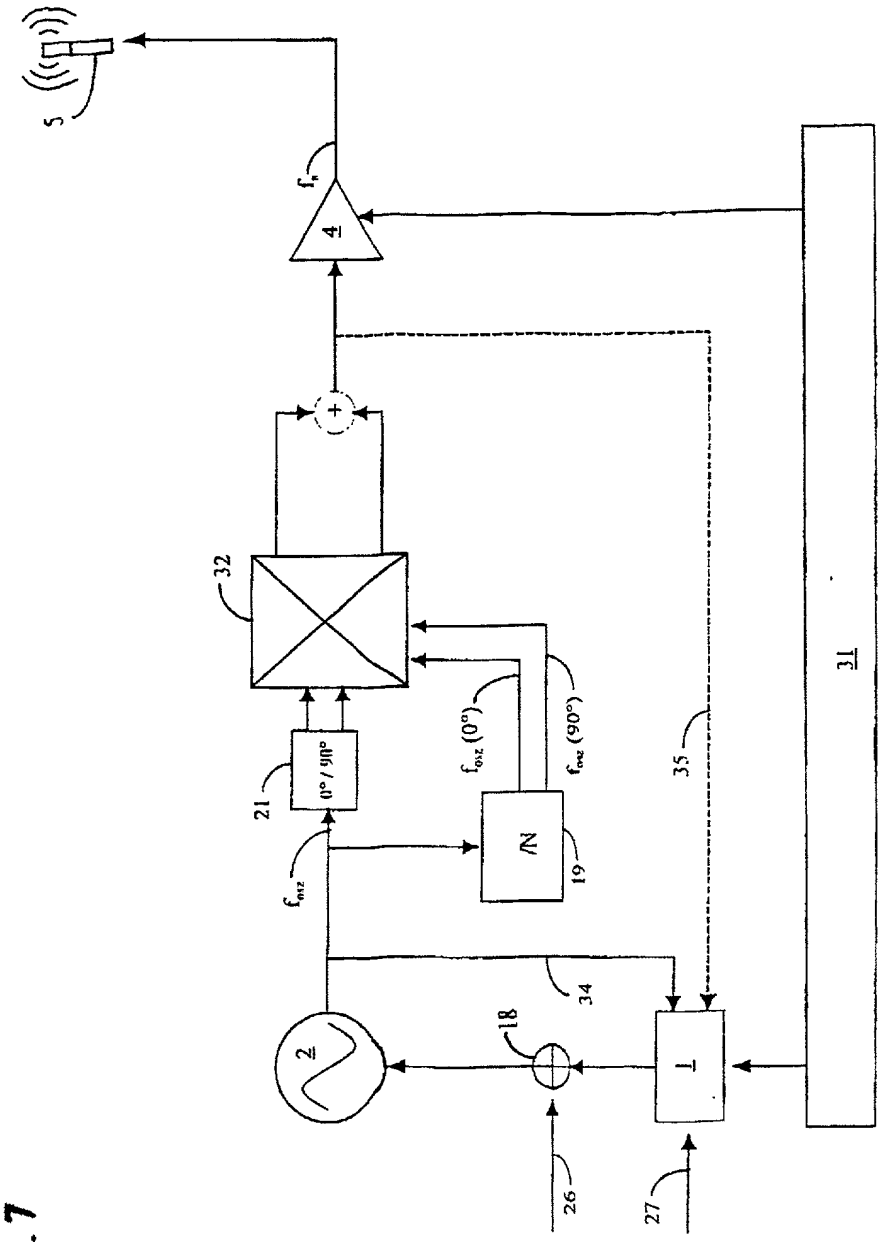


Fig. 7

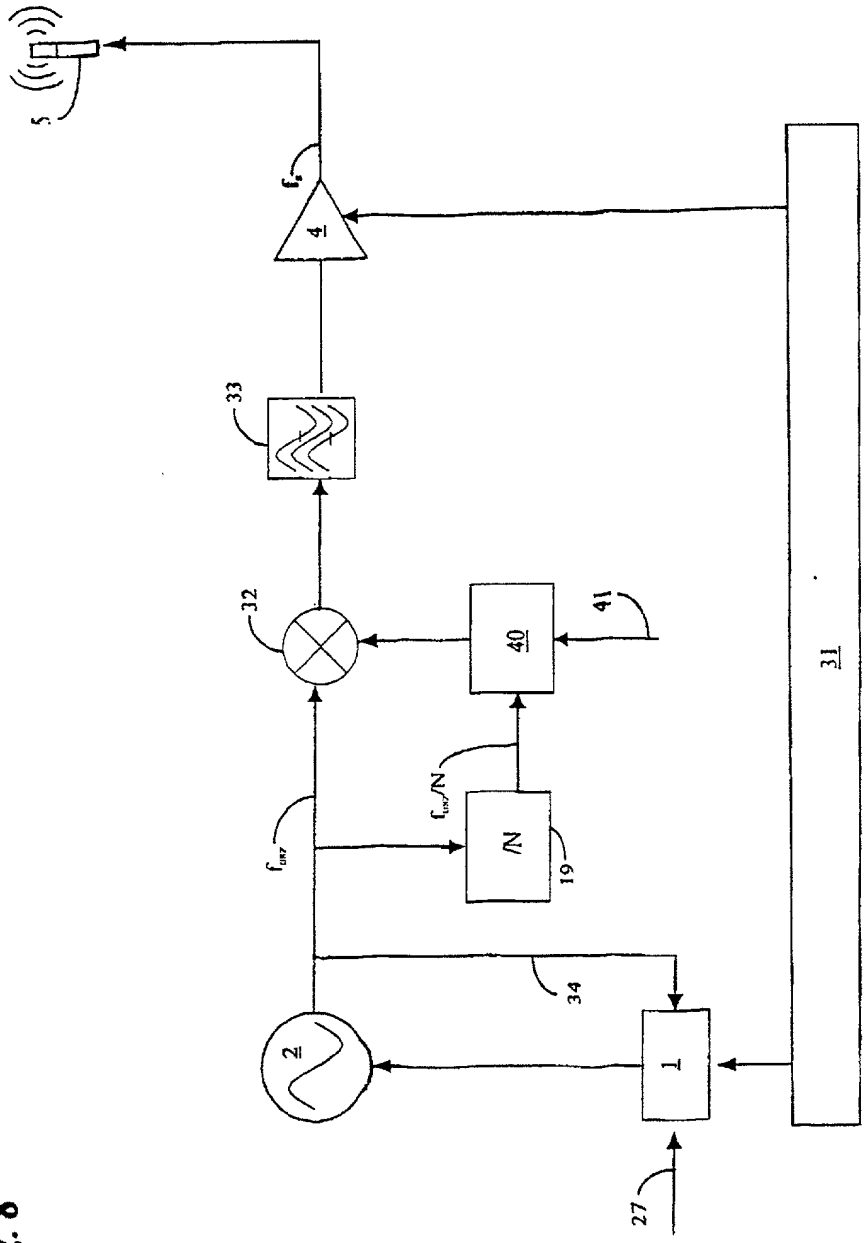


Fig. 8

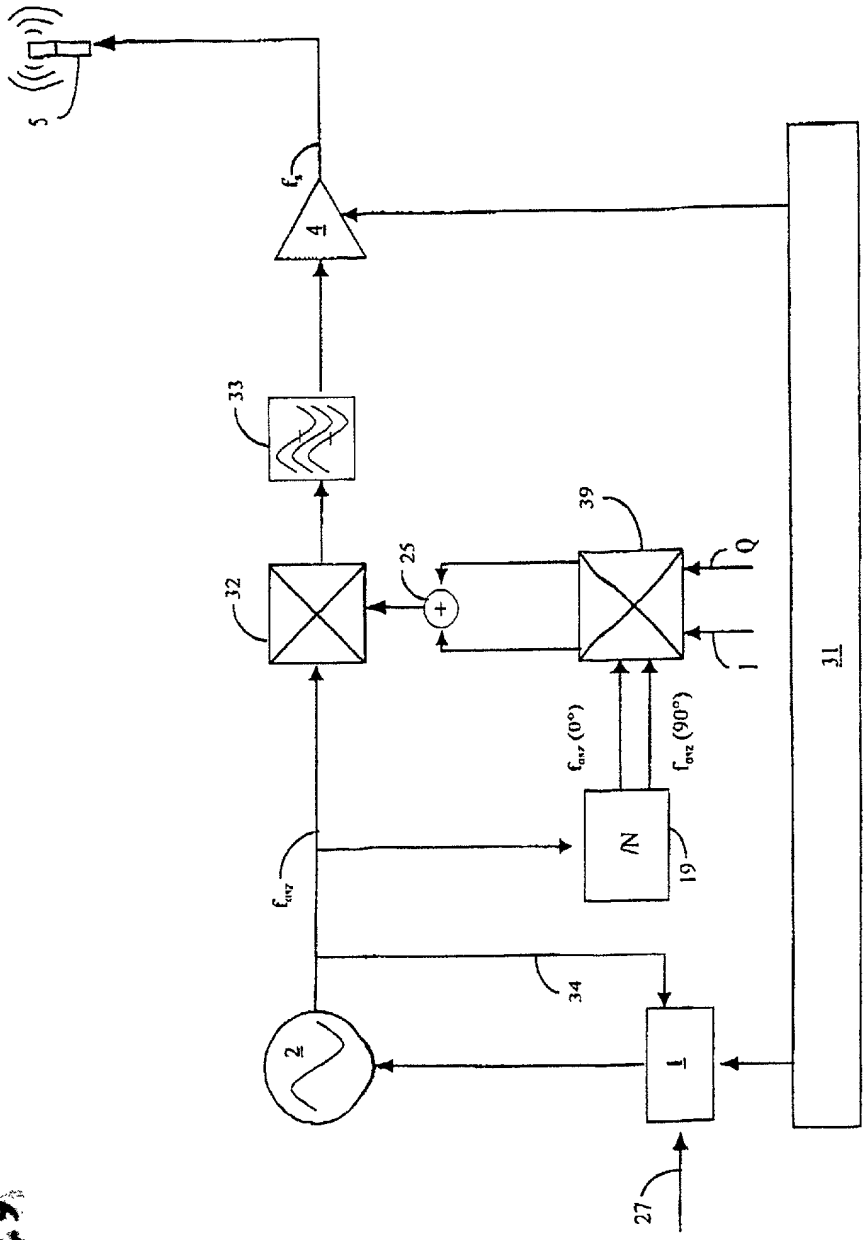


Fig. 9

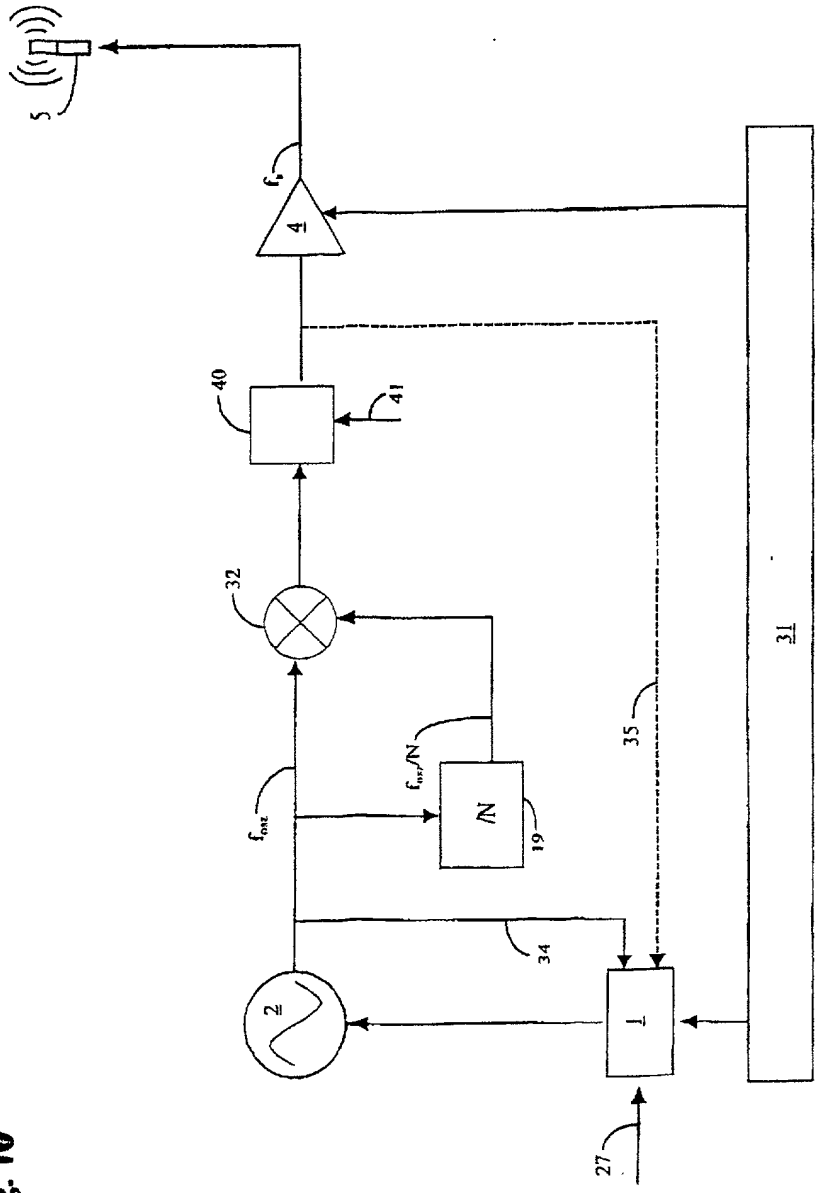


Fig. 10

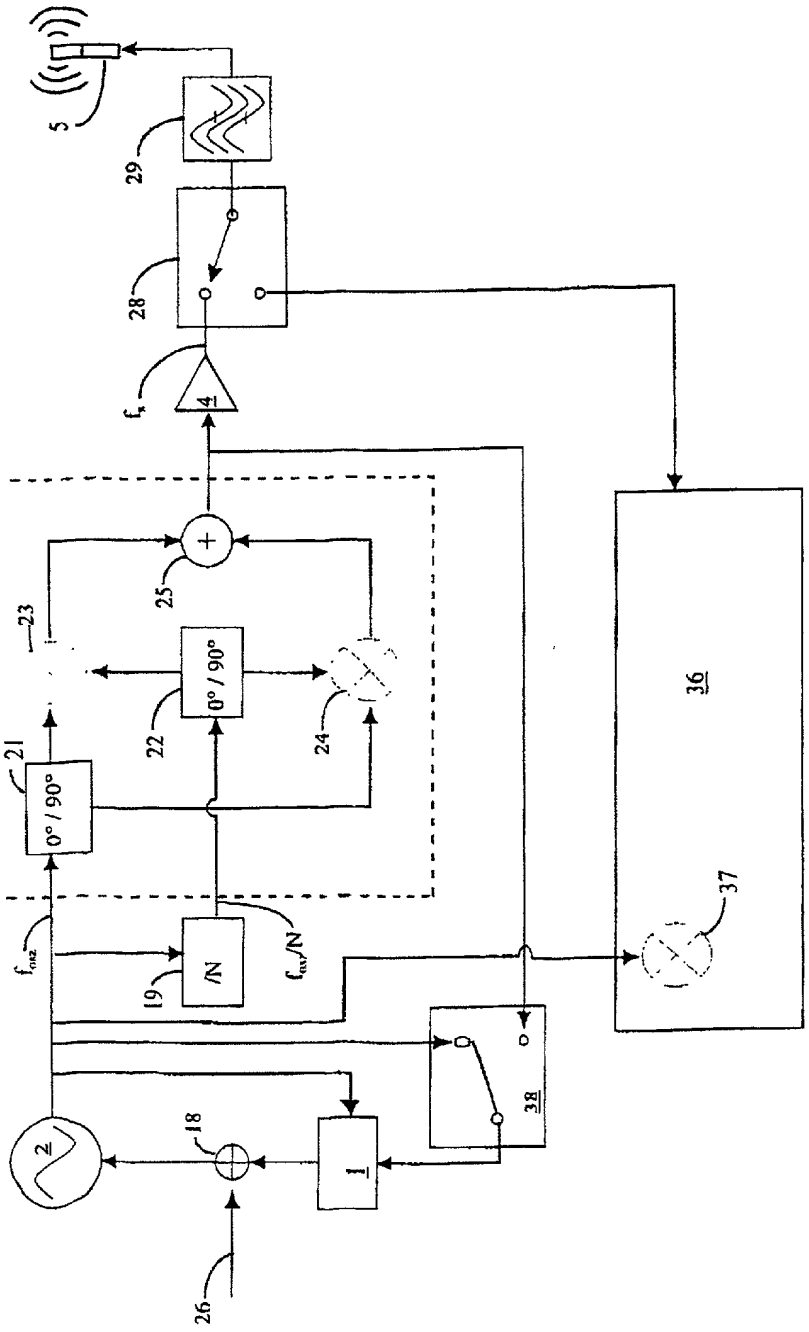

5
29
28
4
f_s
20
23
25
22
0° / 90°
24
21
0° / 90°
36
37
f_{osz}
19
/N
f_{osz}/N
38
2
18
1
26

Fig. 11

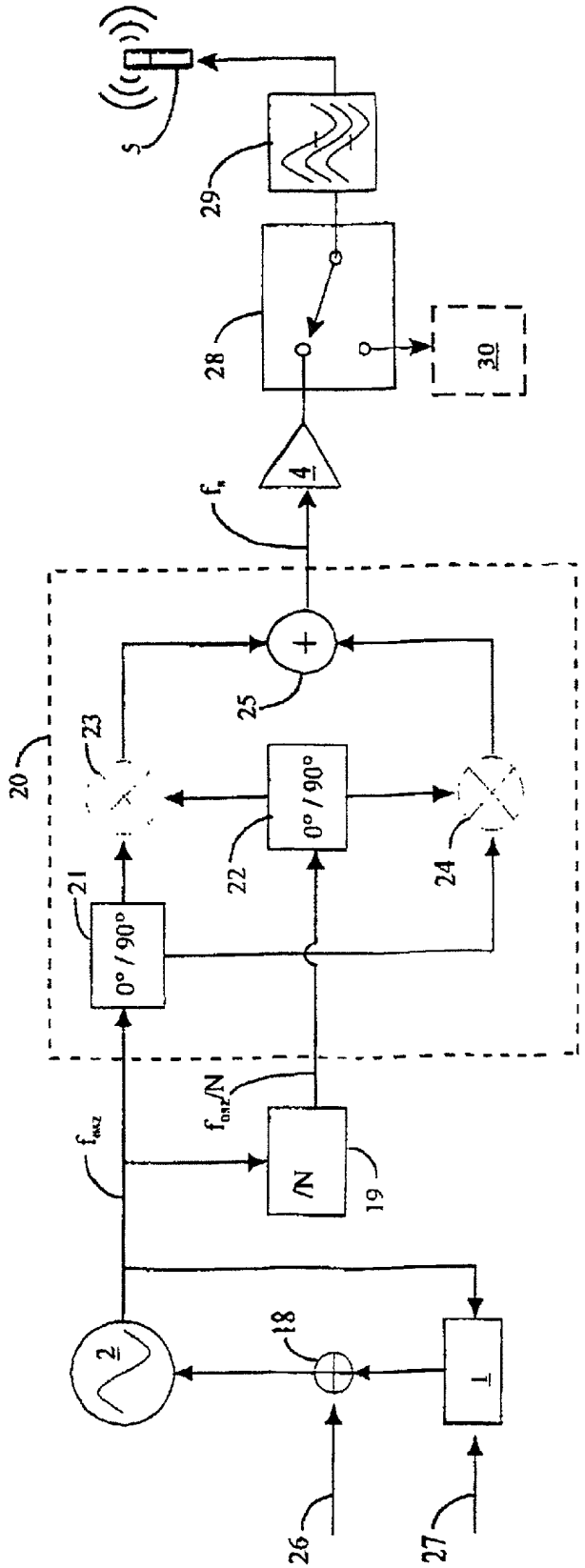


Fig. 12

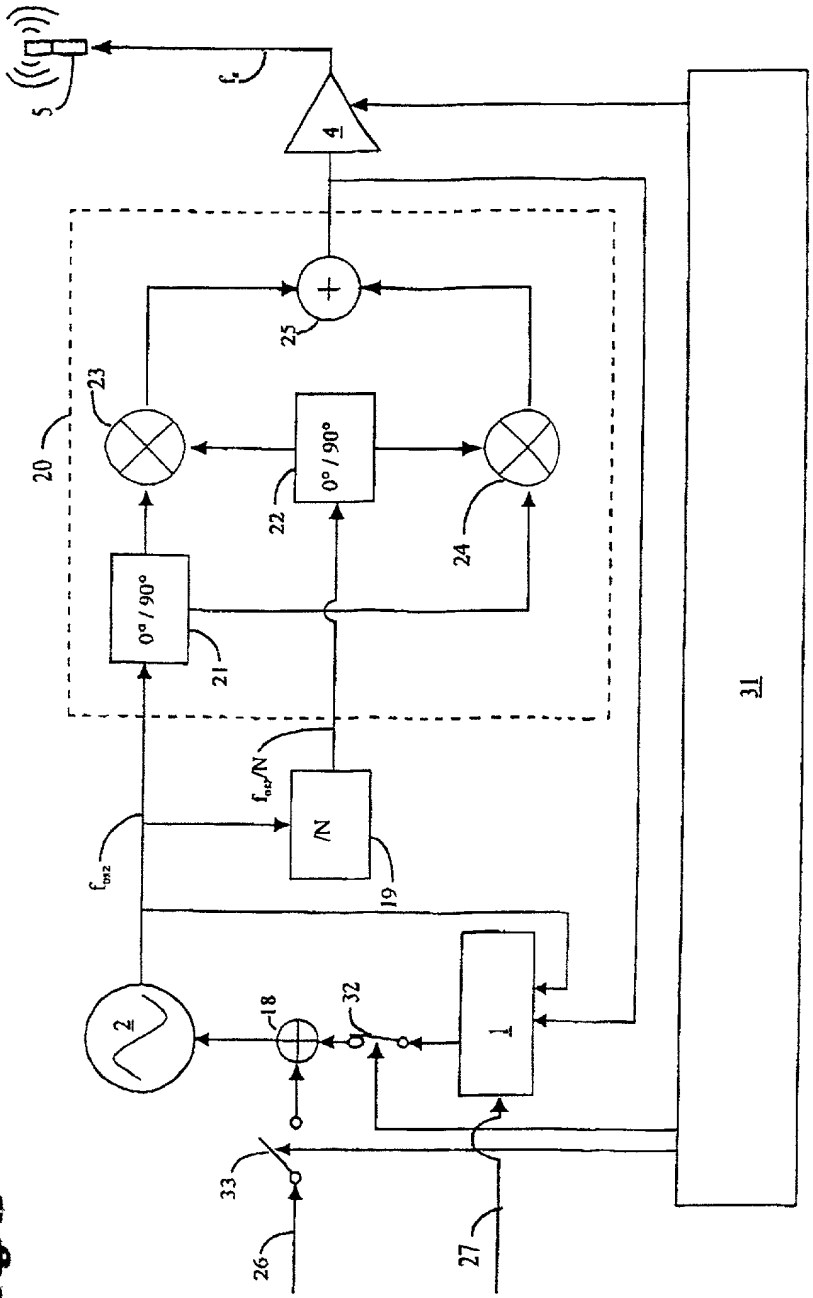


Fig. 13

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Elektronische Schaltungsanordnung zur Erzeugung einer Sendefrequenz

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 30.05.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/01759
eingereicht wurde und am _____
abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Electronic circuit arrangement generating a transmit frequency

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 30.05.2000 as
PCT international application
PCT Application No. PCT/DE00/01759
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a)

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications Priorität beansprucht			Priority Claimed	
19928998.0 (Number) (Nummer)	DE (Country) (Land)	24.06.1999 (Day Month Year Filed) (Tag Monat Jahr eingereicht)	☒ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/01760 (Application Serial No.) (Anmeldeseriennummer)	30.06.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	anhängig (Status) (patentiert, anhängig, aufgegeben)	pending (Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefahrden konnen.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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